THE ELECTRICAL AGE

VOLUME XXXV

July—December, 1905

NEW YORK AND LONDON

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THE ELECTRICAL AGE

Established 1883

Volume XXXV Number 1
$2.50 a year; 25 cents a copy

New York, July, 1905

The Electrical Age Co.
New York and London

A Model Electrically Driven Laundry

By HOWARD S. KNOWLTON

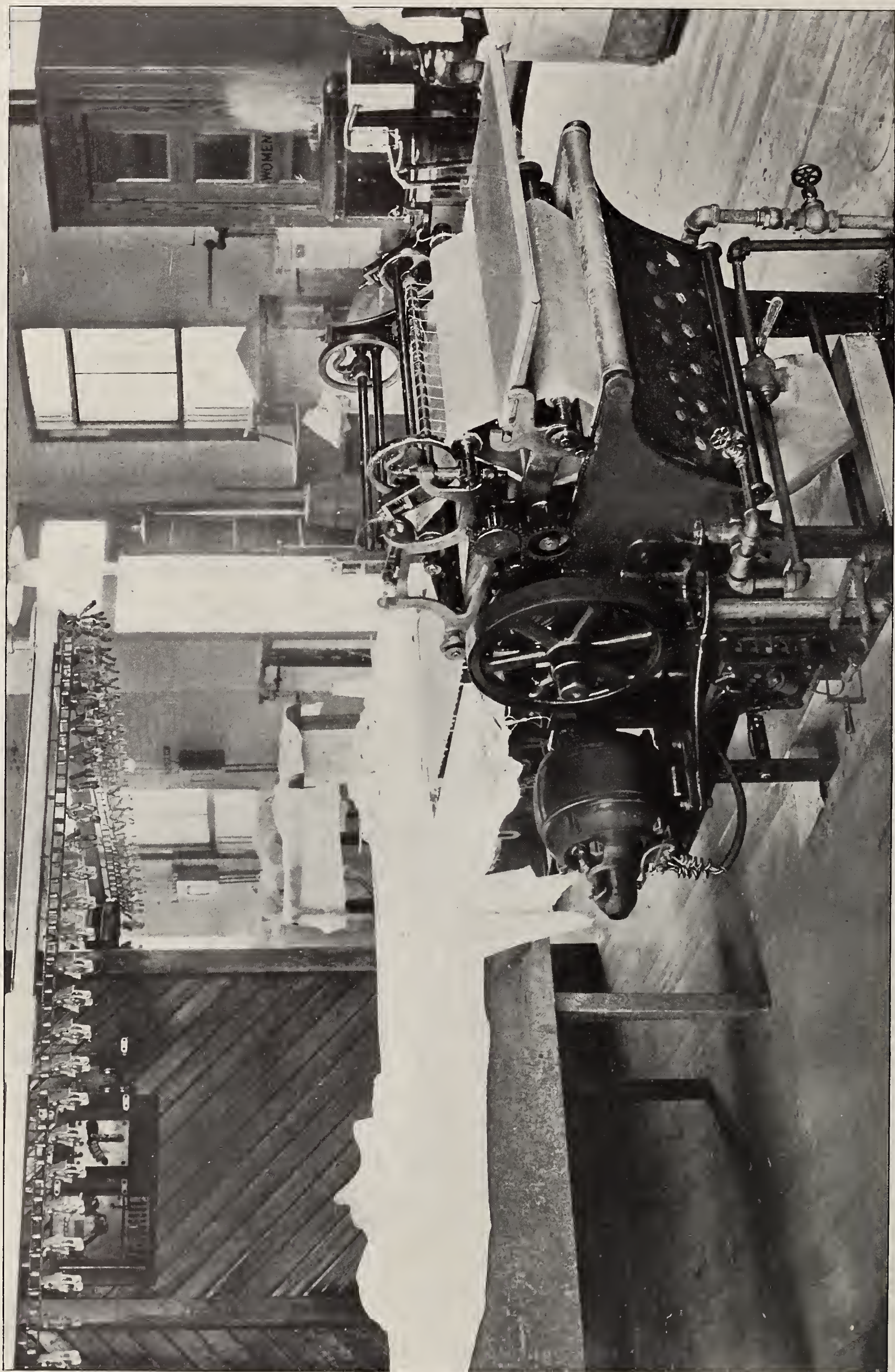
THE ORDINARY HAND IRONING IS DONE WITH ELECTRICALLY HEATED IRONS

ALTHOUGH the advantages of motor driving have in recent years become appreciated in a great variety of industries, the use of electric power in the commercial laundry has been making but slow progress. Recent developments, however, indicate that the modern high-class laundry manager is beginning to realize the broad economy of motor-driven machinery and the unparalleled advantages of electric heaters in certain classes of work. One of the most interesting plants in the United States, if not in the entire world, was placed in operation in Cambridge, Mass., in the fall of 1904, and as an example of the most advanced laundry practice of to-day in the extensive use of electricity, both for driving machinery and for heating purposes, the installation has attracted visitors from all parts of the country.

The plant, which is that of the E. & R. Laundry Company, is located at 209 Massachusetts Avenue, Cambridge, a short distance from Harvard Bridge. The building is a handsome two-story structure of brick and stone, the architecture being a free rendering of the English renaissance style. The main entrance to the office, on Massachusetts avenue, is through a carved limestone vestibule with marble floor and base, and with parallel oak walls. The office is finished in quartered oak, the general effect being that of the Arts and Crafts style, but not as heavy and massive. Below the office is a basement, in the front section of which is an employees' lunch and retiring room, 60 by 20 feet. The rest of the basement is devoted to storage purpose and to the power plant, which latter supplies the building with heat, light and electricity for motor and heating work.

On the second floor, directly over the main office and entrance, are the private offices. Back of the offices, on both floors, are the work rooms, affording about 25,000 square feet of floor space, arranged for conducting the business. The bricks used in the building are of selected water-struck variety laid in Flemish bond. For fire proof purposes, the inside walls are made of concrete, built solid with the brick walls, without the use of laths. In the work rooms and in other places the dados are of glazed brick which can be frequently washed to preserve cleanliness, special attention having been given to hygienic features in the construction of the laundry. An interesting architectural feature of one corner of the building is a tower reached by a spiral stairway, surmounted by a copper tower, which may be used as a fire escape.

The advantages of the motor drive in laundry work are notable. It is not unsafe to assume that in most cases the adoption of motors in such service will show a yearly profit of from 30 to 50 per cent. of the investment required. In a belt-driven plant it is next to im-



FROM THE ELECTRICALLY DRIVEN COLLAR AND CUFF STARCHING MACHINE, HERE SHOWN, THE ARTICLES ARE CARRIED TO THE DRYING ROOM BY THE ELECTRIC CONVEYOR, SHOWN IN THE BACKGROUND, AND ALSO MORE IN DETAIL ON PAGE 3

ANOTHER VIEW OF THE ELECTRICALLY DRIVEN CONVEYOR SHOWN ON THE PRECEDING PAGE

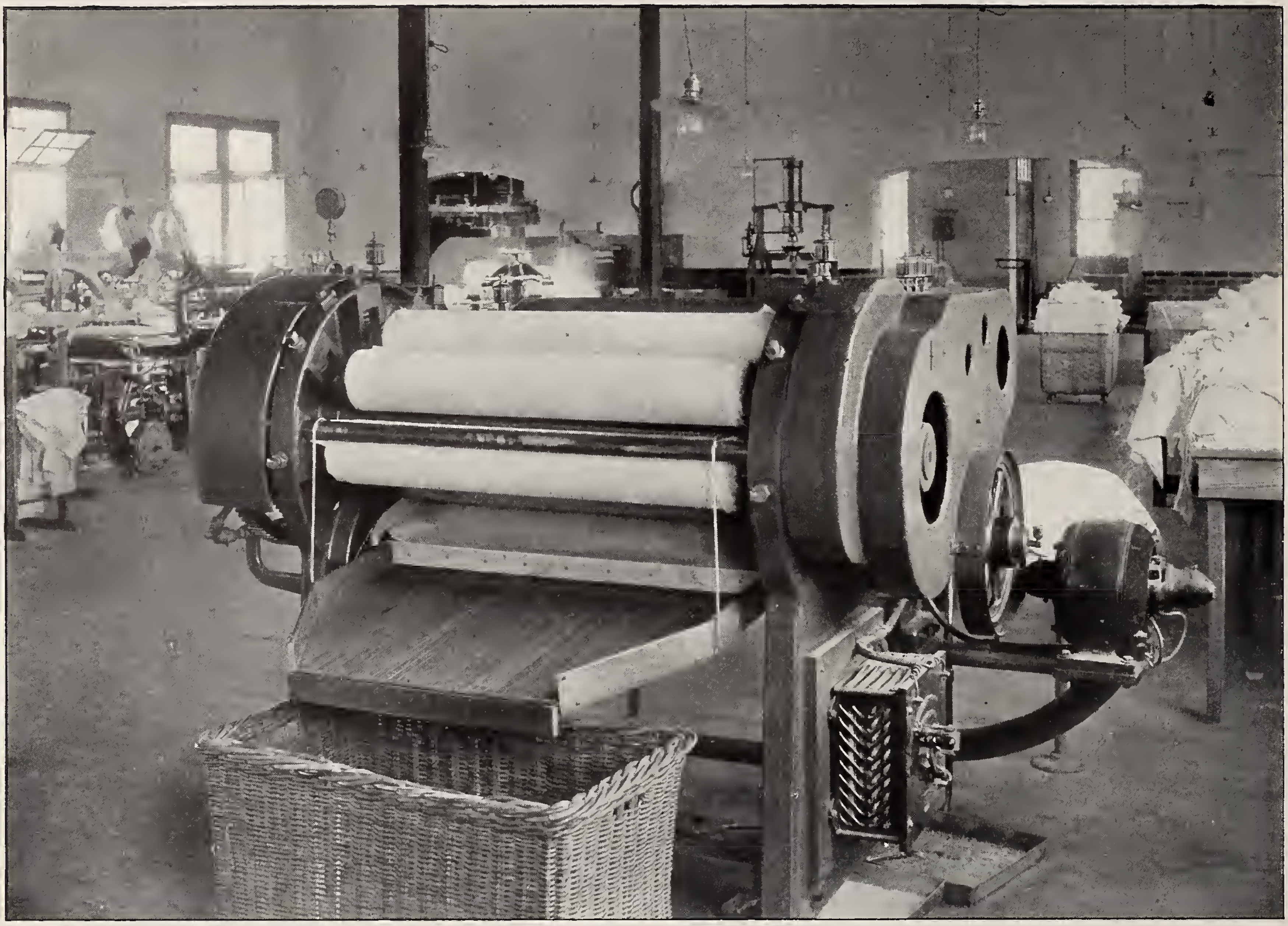
possible to reduce the losses incurred in driving the belts and shafting to less than 10 per cent. of the average power delivered by the engine. In the average plant these losses easily amount to 25 per cent. As the machinery grows lighter, the power loss increases in relation to the transmitted power, so that in some cases tests have shown in steam-driven laundries that fully 50 per cent. of the output of the engine is consumed in driving the shafting and belting. In such instances the actual loss is 100 per cent. of the power used productively, assuming the entire plant is in operation.

In a laundry plant the different departments are not always running at full load, and sometimes some of them will be shut down while others are in operation. If this reduction amounts to one-half the capacity of the laundry, the power loss equals 200 per cent. of that used productively, since the shafting and belts must be kept in motion regardless of the number of machines in operation. In other words, the belts and shafting create by friction losses a fixed charge upon the service rendered, as long as the plant is moving.

The motor drive changes all this, eliminating the greater part of belt and shafting losses. Power is consumed only when machines are in operation, and then only in proportion to the work required. An important feature of laundry work is the arrangement of the machinery so that the work may pass through the laundry with a minimum amount of time lost and of handling while going from one operation to another. Here the line shaft and belt drive preclude flexibility of installation, involving in some cases the use of idlers, quarter-turn belts and other devices which are wasteful of power. The motor occupies no valuable space and may, of course, be placed in any location where wires can be run with safety and convenience.

The possibilities of speed regulation in motor-driven installations are so much superior to those inherent in belt-driven plants, that sometimes the actual investment in laundry machinery is lessened through the increased production in a given time which the electrically-operated outfit makes possible. Thus, the standard speed of a certain machine may be too high for a given work, so that the process has to be gone over with twice. Perhaps part of the work could be done a great deal faster and considerable time saved if it were possible, instead of entailing this additional expense and the possible increased investment to cover two machines to do the work of one, to use an individual motor-driven machine which will do all the work and in such a way as to give the best results in the least time and at the least expense. In addition to the saving in labour a corresponding saving would then be gained in first cost.

Without much question, the cleanliness of electric power is its chief advantage in laundry work. Perhaps no one but a laundryman can realize the amount of labour, expense and vexation caused by clothes being soiled in the process of laundering, or how much of it is due to their coming in contact with greasy belts, to the dust and dirt scattered by the belts or to the oil from the shafts dropped on them. The absolute freedom of electric motors and heaters from dirt ought to be sufficient reason for their adoption in plants newly designed or already operated by belts and shafting. Another great point in favour of the electric equipment is the segregation of repairs which it makes possible. Only the machine affected is thrown out of service,—a marked contrast to the old methods of driving. A prominent manufacturer of laundry equipment, in emphasizing the advantages of the motor drive, states that the cost of re-



THE MANGLES ARE DRIVEN INDIVIDUALLY BY ELECTRIC MOTORS

pairs and replacements amounts to less than half of what they did under the old régime.

The power plant of the E. & R. Laundry is a compact installation. It consists of a 150-H. P. horizontal-return tubular boiler, made by Edward Kendall & Sons, of Cambridgeport, Mass. The boiler is hand fired, and operated at 90 pounds steam pressure. Coal is dumped from wagons directly into a bin at one end of the boiler room, or in front of the boiler itself, as desired. Adjoining the boiler room is the engine room, containing a 50-K. W. compound-wound Crocker-Wheeler 110-volt generator direct connected to an 11-inch by 12 inch American-Ball horizontal automatic cut-off engine making 275 revolutions per minute. Steam is supplied through a 4-inch pipe, and a Cochrane separator is placed in the piping just before the engine valve. The feed pump is of the Blake pattern, $2\frac{3}{4}$-inch by $4\frac{1}{2}$-inch by 4-inch, and it is set up in one corner of the engine room. Near the engine is a small switchboard which controls the various power and lighting circuits in the building. The only noteworthy feature of this board is an emergency lighting switch connected with the circuits of the Cambridge Electric Light Company, which can be thrown in in case the regular power supply from the generator fails. There are 35 16-candle-power incandescent lamps wired to this switch, and located at various points in the building to avert any panic among the employees which might result from sudden darkness. There are about 175 16-candle-power incandescent lamps in the laundry, 5 enclosed arcs operated on the 110-volt circuits, and electric motors to be considered later.

The washing machines are located in the workroom on the first floor, and are eight in number. They are divided into two groups of four each, each group being driven by a 5-H. P. 110-volt motor bolted to the ceiling. All the wiring is carried in iron armoured conduits, circular loom duct being used in the immediate vicinity of the machinery. The motors are all of the Watson type, specially designed for laundry service, and manufactured by the Mechanical Appliance Company, of Milwaukee, Wis. Practically all the other machinery of the laundry was made by the Barnes & Erb Co., of Philadelphia. Each of the washing machines has a capacity of 100 shirts and 700 collars and cuffs. Ten different waters are applied to each washing. The clothes are revolved by being carried around in a cylinder of very smooth maple which rotates in water in an outside case of Georgia pine. The inside cylinder is well perforated to allow the water to thoroughly penetrate the folds of the clothes. The group-driving was arranged to enable half the machines to be shut down at once if necessary.

Five extractors are also in use in the first floor workroom. One of these is 22 inches in diameter, driven direct by a 1-H. P. motor, while the others are 26 inches in diameter, driven by a 1.5-H. P. motor each. The clothes are placed in the copper basket of one of these machines, while wet, and the basket is revolved at a speed sufficient to throw the water off from the clothes by centrifugal force through the perforated side of the basket, whence it is discharged through suitable waste piping. The extractor baskets are arranged to be self-balancing under uneven loads, and the machines are fitted with ball bearings. In this room are

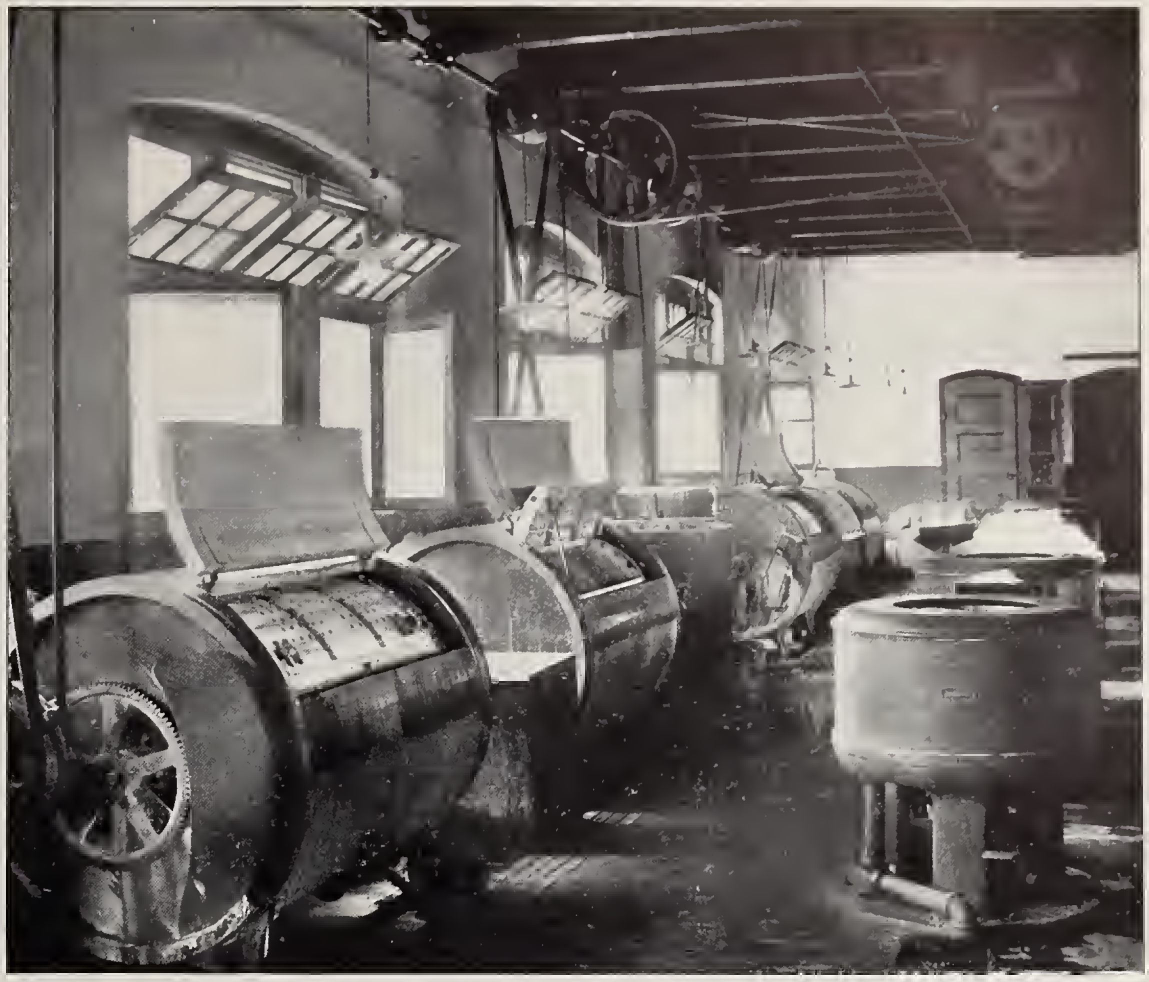
also two mangles, one a 100-inch 5-roll machine weighing 5.8 tons for pressing and drying linen, and the other a standard handkerchief machine. The larger mangle is direct-driven by a 2.5-H. P. motor, and the smaller one by a $\frac{1}{4}$-H. P. motor. There is also a $\frac{1}{4}$-H. P. fan motor on the larger mangle for air circulation. The heated surfaces in the mangle are covered with asbestos, except where the linen comes in contact with them. Steam is used for heating the mangle rolls. The asbestos tends toward steam economy just as does the insulated covering of a steam pipe. Full boiler pressure is used on the mangles.

The upper floor workrooms are divided into two sections: a starching department and an ironing room. There is also a space set aside with compartments for sorting and storage purposes, about 7000 customers now being on the company's card catalogue list. All the different rooms are connected by an intercommunicating telephone system.

The starching room contains one collar and cuff starching machine driven by a $\frac{1}{4}$-H. P., 450 revolution per minute motor; a 25-inch Barnes & Erb extractor driven by a 1-H. P. vertical motor making 900 revolutions per minute; a "hurricane" dry room for flannels and fancy wear; a collar and cuff dry room, and a shirt dry room.

The automatic conveyor dry room, as each of the two latter apartments is designated, is one of the most interesting features of the laundry. It consists of an enclosed space or large cabinet heated by a steam coil, and an endless chain conveyor which carries the goods from the starchers through a drying process and automatically deposits them in a receptacle prior to ironing. The steam coil is placed on both sides of the room, which equalizes the heat, and a motor-driven fan placed over the conveyor distributes the heat by circulating the air. The goods remain in the room only long enough to become thoroughly dried, and their colour is not disturbed. They pass into the room one piece at a time, which does not disturb the temperature (which is well over 300 degrees F.) as it would be disturbed if a large rack of wet, cold goods was pushed in at once.

The collars and cuffs ordinarily require about 20 minutes for the drying process. The conveyor of the collar and cuff dry room is driven by a $\frac{1}{2}$-H. P. motor, and the fan by a $\frac{1}{4}$-H. P. motor. The shirt conveyor is driven by two $\frac{1}{2}$-H. P. motors, and there are two fans, each run by a $\frac{1}{4}$-H. P. motor. The speed of the conveyor chains averages about 4 feet per minute. Be-



EIGHT WASHING MACHINES, IN GROUPS OF FOUR, ARE DRIVEN BY TWO OVERHEAD MOTORS. THE CENTRIFUGAL EXTRACTORS SHOWN AT THE RIGHT ARE DRIVEN BY INDIVIDUAL MOTORS

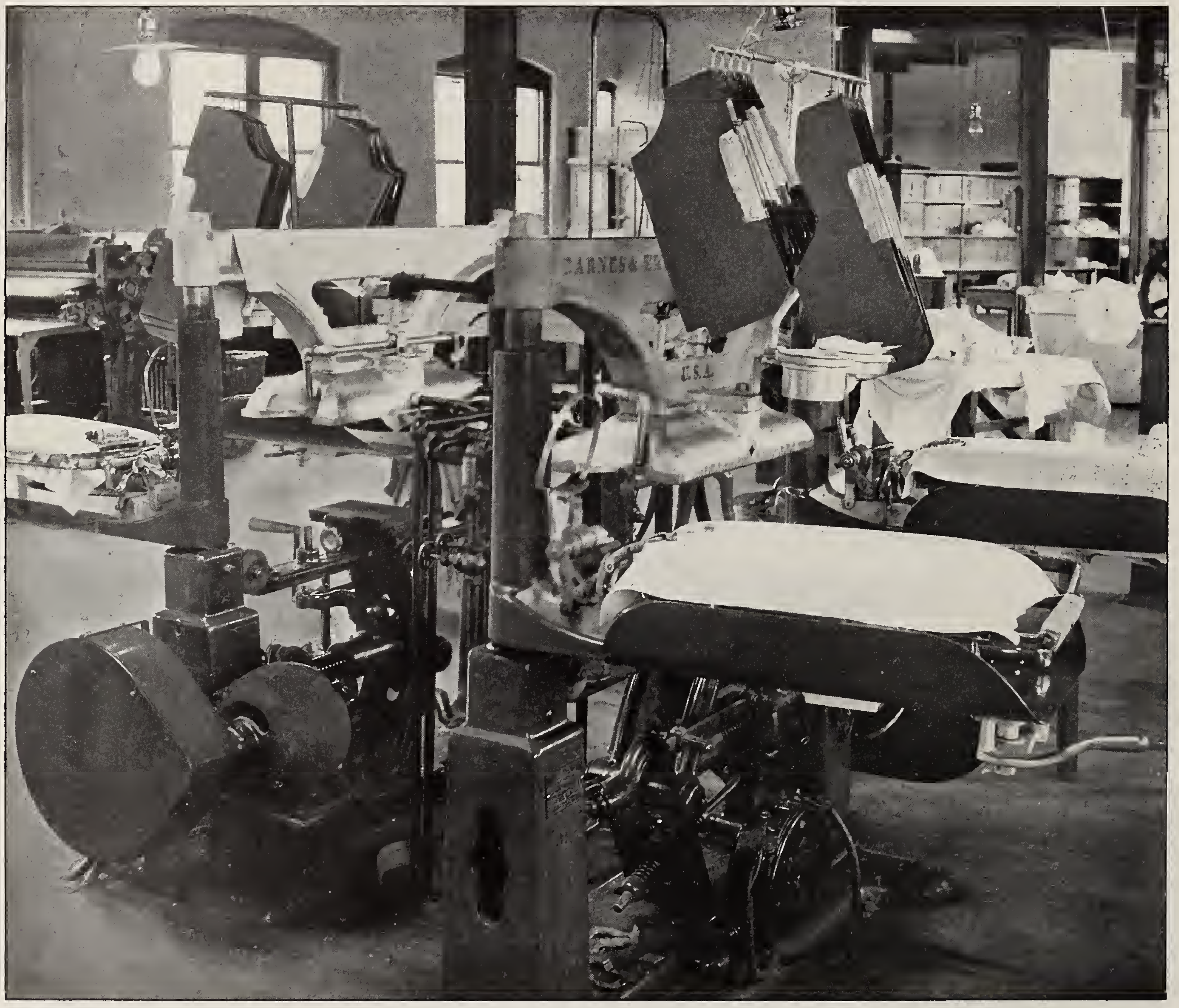
THE BODY IRONERS, TOO, ARE ELECTRICALLY DRIVEN AND ELECTRICALLY HEATED AS WELL

low the chains hang fingers which hold the goods, two collars to each pair of fiingers, and as the fingers pass a forked arm at the conclusion of the journey, the arm causes the fingers to rise and automatically lift the goods from their supports, dropping them in the basket which is placed beneath at the end of the travel. In order to enable different lots of goods to be separated, the conveyor chains are arranged to operate a circuit-closing device and ring a bell at the end of each lot, attracting the attendant's attention.

Two electric elevators run to the upper floor. One of these has a capacity of 3000 pounds and is used in handling starched goods. It is driven by a 5-H. P. motor, and is provided with an automatic pilot lamp which shows when current is on the motor. The motor is installed in a corner of the shirt-starching department. The other elevator is used for freight service, and runs from the ground floor to the ironing room. It has a capacity of 5000 pounds, and is run by a $7\frac{1}{2}$-H. P. motor.

The ironing room contains an interesting assortment of electrically-operated machinery. The individual drive is used throughout, with the exception of a Torrance seam dampener, a Clark & Zeigler turn-down collar shaper, and a Manhattan collar and cuff shaper. These machines are all mounted on a table, and are belt-driven from a Watson motor taking 3.8 amperes at 110 volts and making 560 revolutions per minute. The capacity of these machines is from 25,000 to 30,000 pieces a week, between 4 p. m. Monday and Saturday noon. There is also a collar and cuff ironing machine direct driven by a 1-H. P. 110-volt motor and having a capacity of 50,000 pieces per week, and a shirt dampening machine driven by a $\frac{1}{4}$-H. P. motor.

Instead of ironing shirt bosoms by rubbing friction, the E. & R. Laundry uses 3 bosom presses, each driven by a $\frac{1}{2}$-H. P. motor and having a capacity of 500 shirts per day. The principle of the bosom presses is the application of extreme pressure to a flat padded surface against a hot polished surface. The dampened goods being subjected to this pressure, take on a beautiful finish which flattens the weave of the material, brings the starch to the surface, and makes a perfectly smooth shirt, at the same time drying out the dampness and leaving the goods dry and stiff. There is no motion or friction, and the goods remain under presure until dried, thus obviating any wear or stretching of the goods and



EACH OF THE THREE BOSOM PRESSES HAS ITS OWN MOTOR

making it possible to mold the shirt into proper shape and give it an appearance that cannot be obtained in any other way.

For body ironing, there are two electrically heated and driven machines having a capacity of about 2500 shirts a week. Each is run by a 1-3-H. P. motor making about 600 revolutions per minute, and about 50 amperes at 110 volts are required for heating each one. All the electric heating apparatus was supplied by the Simplex Electric Heating Company, of Cambridge, Mass. There is also an electrically heated sleeve ironer in operation. It takes 16 amperes at 110 volts. Three different heats,—low, medium, and high,—are provided with these ironers, and the arrangement insures a clean, cool, sanitary laundry without the dirt, flame, wasted heat and vitiated air which accompany the use of gas heated irons and rolls.

In severity of service it would be difficult to find more trying conditions than those imposed on the body ironers. These machines are often reversed from full speed as frequently as once a second, and usually from 15 to 20 times a minute. The motors are standing it well, and reverse so quickly and smoothly that one has to watch the commutators sharply in order to catch the instant of stopping. Were it not for the slight sparking which accompanies each reversal, one would not realize the extraordinary demands which such violent fluctuations in load impose upon the motors, which were specially built for the service.

The flat-iron equipment of the E. & R. Laundry is especially complete, and it is all electrically heated and of Simplex make. There are so-called Tyler irons for shirtwaist work, taking 4 amperes at 110 volts each; duck irons taking 2.8 amperes at 110 volts, and other irons taking from 4.9 to 6.2 amperes at the same potential. Under each iron rest is an automatic switch which cuts the current down one-half when the iron stands upon the rest, keping it hot enough to prevent undue cooling, but economizing in the use of power. As the electric heat is always uniform, there is no time lost in travelling from the work table to the heater, as in gas or stove heated ironing, the output per machine and per operator is notably increased.

Gas-heated laundries are often almost uninhabitable in the summer time on account of the hot and poisonous air, and the comfort of electric heat has to be experienced but once to be appreciated. The quality of the work is also improved by the use of electric irons. In the E. & R. plant, iron brackets of neat design rise from the floor and extend over the tables to facilitate the handling of the flexible cord. Conduits are also run in the floor and brought to frequent outlets in the boxes where fused, and switches are provided for future use.

The prices of the E. & R. Laundry are the same as those of any high-class establishment, and the plant is under the management of R. H. Gilmore, to whose painstaking courtesy the writer is indebted for the material which forms the basis of this article. The laundry is well worth a visit from any engineer who is interested in intensive and economical production.

A Blow at Municipal Ownership

AT the recent municipal election in Chicago, it will be remembered, Judge Dunne, the advocate of municipal ownership of public utilities, was elected Mayor. James Dalrymple, manager of the Glasgow tramways, was invited by Mayor Dunne to visit Chicago and advise as to the best method of placing the street railways under municipal control. Much was hoped for from Mr. Dalrymple toward furthering the cause of municipal ownership.

In a recent interview, however, given in the New York "Sun," he said that he had seen enough of the United States to be convinced that municipal ownership will never do in a republic, and that the idea is one of the great dangers with which the people must contend.

"To put street railroads, gas works, telephone companies, and the like, under municipal ownership," he said, "would be to create a political machine in every large city that would be simply impregnable. These political machines are already strong enough with their control of policemen, firemen and other office-holders.

"If, in addition to this, they could control thousands of men employed in the great public utility corporations, the political machines would have a power that could not be overthrown. I came to this country a believer in public ownership. What I have seen here, and I have studied the situation carefully, makes me realize that private ownership under proper conditions is far better for the citizens of American cities."

The first patent granted by the Chinese Government is for an electric lamp, the inventor of which is an inhabitant of Nankin, the old capital of the Chinese Empire. The lamp is called the "bright moonlight," and the inventor asserts that it is far superior to lights of foreign make hitherto sold in Shanghai and other Chinese cities.

A Home-Made Soldering Iron Heater

A VERY convenient electric soldering-iron heater is in use at the Druid Hill sub-station of the United Railways & Electric Company in Baltimore. It is a simple, home-made affair, consisting of a bank of five 110-volt lamps, a copper plate bent at right angles, an arc lamp carbon ⅝-inch in diameter, and suitable connecting wires. The copper plate is mounted upon an ordinary fire brick, and the carbon is allowed to rest upon another, a fire-brick cap being placed upon it, sufficiently channelled out to enable the end of the carbon to be well covered. The carbon is connected to the positive terminal of the trolley circuit and the copper plate to the negative, the lamp resistance being interposed to cut down the potential. An old field rheostat is also in series with the apparatus for regulating the current flow.

The heater is operated by bringing the carbon against the copper plate and withdrawing it, forming an arc which quickly heats the plate sufficiently to enable soldering to be done. The use of the gasoline torch is entirely dispensed with, and once the copper plate is heated, it readily stays hot with little attention. The cleanliness and convenience of the apparatus are notable. A small electric soldering iron for delicate work is also in use at this sub-station. It consists of an insulated handle carrying two terminals with sufficient spring to enable an arc to be established between them when they are pressed together and separated. Suitable resistance is interposed between the power circuit and the arc points to prevent undue rush of current.

Artificial Rubies from the Electrical Furnace

ACCORDING to a recent consular report, artificial rubies have been produced in France by reducing small, natural rubies into a very fine powder, which is melted in an electric furnace, cooled rapidly, and crystallized. The product obtained, from what was of little worth, on account of minuteness, possesses a comparatively high value. The main difficulty encountered is to prevent cavities and fissures in the crystals. The new process cannot be employed with emeralds and sapphires, as they become discolored by the action of the heat.

The International Association of Municipal Electricians will hold its annual meeting at Erie, Pa., on August 23, 24, and 25.

The National Electric Light Association

The Denver Convention, June 6-11

PIKE'S PEAK

As briefly mentioned in these pages last month, the twenty-eighth annual convention of the National Electric Light Association was held at Denver, Col., beginning on June 6, and proved to be the most successful and most largely attended gathering in the history of the organization. About 600 delegates were present, representing every State in the Union and Canada, and a large number of excellent papers were read and discussed.

As already noted, the following officers were elected for the coming year:—

William H. Blood, Jr., of Seattle, Washington, president; Arthur Williams, of New York, first vice-president; Dudley Farrand, of New York, second vice-president; W. C. L. Eglin, of Philadelphia, secretary and treasurer.

Three new members of the executive committee were appointed to fill vacancies made by retiring members. These were Charles L. Edgar, of Boston; Frank W. Frueauff, of Denver; and John Martin of San Francisco. The remaining members of the executive committee are L. A. Ferguson, of Chicago; Harry Bottomley, of Fall River; Alexander Dow, of Detroit; Samuel Scovil, of Cleveland; A J. De Camp, of Philadelphia; and W. F. White, of New York. The retiring members are A. C. Dunham, of Hartford; P. G. Gossler, of New York; and H. T. Hartman, of Philadelphia. A spirited contest was promised for the office of president, there being several rival candidates in the field with chances favouring Mr. Blood and Mr. Frueauff, of Denver. Before the nominating speeches were made, however, the several forces came to an understanding, and the election of Mr. Blood was made unanimous.

In the opening address by President Ernest H. Davis to the delegates at the initial session, full recognition was made of the growing sentiment of the people for municipal ownership of public utilities. Significant and urgent advice was given to the controllers of the big concerns to be reasonable in all charges and faithful in living up to franchise terms. It was, in fact, a note of warning, that unless the suggestions were complied with, the municipalities would force the companies out of business.

"Colorado," said the president, after he had congratulated the association that Denver had been selected as the convention city, "has located within its borders a large proportion of the central stations, and the representatives of them are now members of this association; hence the importance of our coming here. The interest of the central station, considered as an industry, is what has lately received the best work and thought of your association, the vital questions being no longer pre-eminently those of management or type of plant, but rather those relating to the stability and legitimate earning power of the industry.

"The one great and constant men-

DENVER.—A VIEW OF BROADWAY, SHOWING FOUR OF THE LARGE HOTELS—THE BROWN PALACE IN THE BACKGROUND ON THE LEFT, THE SHIRLEY ANNEX AND THE SAVOY IN THE RIGHT FOREGROUND, AND THE HOTEL METROPOLE IN THE BACKGROUND AT THE RIGHT

A VIEW OF DENVER

SIGHT-SEEING DURING THE CONVENTION—FRYING PAN RIVER ON THE COLORADO MIDLAND RAILWAY

ace to the industry is unwise, burdensome and restrictive legislation by the municipality and the State. The right to tax is the power to destroy. The power to regulate contains the germs of confiscation, in whole or in part. The regulation of the industry by a commission with powers such as are vested in the gas and electric commission of the State of Massachusetts may be proper and satisfactory as safeguarding both the rights of the public and the investor, but the regulation by a commission brought into being by a manufactured public sentiment and having its inception in politics, and not primarily nor honestly to remedy any admitted public oppression, or to properly regulate the use of public franchises, cannot be fair either to the public or to the investor, and must result in gross injustice to the industry.

"The association should not be passive, while laws placing the industry under the regulations of commissions are passed by the several states, without making proper suggestions whereby such laws would be made reasonable and uniform in their provisions. Nor should it permit without protest the passage of any laws admittedly unduly restrictive and burdensome. The object should be to have the general laws of the several states relating to the industry conform to some standard, fair both to the public and the industry. I would therefore recommend the appointment of a standing committee on legislation to aid in protecting the interests of our members should occasion arise.

"Another important question is that of municipal ownership, which, while yet limited generally to the construction and operation by municipalities of plants for public lighting, is more than likely to result in the general attempt to engage in private and commercial lighting, as supplementary to public lighting.

"By way of self-protection, the central stations should more than live up to the obligation of its franchises, should furnish public lighting at reasonable prices and serve the public so well that any agitation started for political or personal ends will not receive the support of a justly indignant public.

"As the basis of the argument in favour of municipal ownership is largely that of a reduction in the cost of public lighting to the taxpayer, we should be prepared to answer this claim, as can be done by the concrete results of the operations of existing municipally operated plants. It is to be regretted that the League of American Municipalities has not accepted the proposition repeatedly made by the National Electric Light Association to join in a thorough and impartial investigation of the results of the operations of the existing electric lighting municipal plants in the country. We know, but the public does not, that such results do not justify nor support even a part of the claims made by the advocates of municipal ownership.

"While not strictly within the objects of the association, it would be well for our members to consider the advisability of consolidating street railway, gas and electric companies in any given locality, as, not only would the public be better served, but the total investment would be more stable and the results equally satisfactory."

Mayor Speer's address of welcome pleased the delegates greatly. He said in part:—

"It is a pleasure to me to welcome such a representative body to our city. I, as mayor, was particularly glad that you gentlemen would come and see our great city and learn of

the great resources of our State. While Denver lacks some of the ornaments and decorations that are pleasing to the eye, our energetic citizens are fast building up the city, and we intend to fulfill the prophecy that Denver will at an early day rival the best and greatest of your eastern cities."

Mayor Speer detailed at length the resources of the country as to its mining and agricultural industries and the vast natural advantages for manufacturing. He closed with warm words of welcome, and told the visitors that the city was theirs.

President Davis responded with a few appropriate remarks, and in a businesslike manner announced the order of work for the convention. The progress report was called for, and was given by T. Commerford Martin, of New York. His paper under this heading was encouraging and interesting. A paper on the "Paramount Importance of Choosing Standard in Preference to Special Machinery" was read by David Hall, of Cincinnati, and "Insulation Testing, Apparatus and Methods" was discussed by C. E. Skinner, of Pittsburgh.

The remainder of the day was given over to the consideration of the following papers:—"Automatic Synchronizing of Generators and Rotaries for Light and Power Systems," by Paul MacGahan, Pittsburgh; "Notes on Rotary Converters and Motor-Generators for Lighting and Power Systems," by Louis E. Bogen, Cincinnati; "The Organization of Working Forces in Large Power Houses," by W. P. Hancock, Boston; "Operating Features of the Curtis Steam Turbine," by A. H. Kruesi, Schenectady, N. Y. W. C. L. Eglin, chairman, gave a report of the committee on steam turbines.

On the second day of the meeting, June 7, the following papers were read:—"Series Alternating-Current Motors for Industrial Work," by Clarence Renshaw, Pittsburgh; "A New Type of Single-Phase Motor for Elevator Work," by S. Percy Cole, St. Louis; "Long-Distance, High Tension Transmission in California," by John A. Britton, San Francisco; "Present Methods of Protection from Lightning and Other Static Disturbances," by Alex. Dow and Robert S. Stewart, Detroit, Mich.; "The Nernst Lamp; Its Present Performances and Commercial Status," by E. R. Roberts, Pittsburgh; "The Choice of an Insulated Cable," by Wallace S. Clark, Schenectady, N. Y.; "Some Investigations of Induction Losses," by E. P. Dillon, Colorado Springs; "Mercury Arc Rectifiers," by P. D. Wagoner, Schenectady, N. Y.; "Advertising Methods," by Percy Ingalls, Newark; "Sign and Decorative Lighting," by La Rue Vredenburgh, Boston; "Free Signs and Flat Rates," by C. W. Lee, Newark; "Progress of Electric Heating," by James I. Ayer, Boston; "Purchased Electric Power in Factories," by E. W. Lloyd, Chicago; and "District Steam Heating," by W. H. Blood, Jr., Seattle. Several of these papers were printed in the June number of THE ELECTRICAL AGE, while others are given elsewhere in this issue.

The "Question Box," edited by Homer E. Niez, of Boston, was unusually comprehensive, and contains much practical information. Its development during the four years of its existence is well shown by the following figures:—

Year	Number Headings	Number Questions	Number Contributors	Number Answers
1902.....	..	71	..	303
1903.....	..	193	125	682
1904.....	23	424	188	2,178
1905.....	26	545	227	3,057

The educational value of this volume, as Mr. Niez said, is one of its important functions, and should be constantly borne in mind when considering its growth and development.

PLATTE CANYON ON THE COLORADO & SOUTHERN RAILWAY, FAMOUS FOR FISHING

The information given by one member is valuable to many, and in adding to the fund of knowledge he is enriching others at no cost to himself, as all are working along similar lines, but in different places.

"Wrinkles," too, edited by H. C. Abell, of New York City, this year sustained the reputation gained at earlier meetings.

The executive session was held late on Thursday afternoon, June 8, so that the delegates could have the evening free. At this session the

PIKE'S PEAK AVENUE AT COLORADO SPRINGS

chief report was submitted by Arthur Williams, of New York, with regard to the condition of the municipal ownership agitation in various big cities throughout the country. The report was submitted in a bound volume, and gave a very complete statement, with statistics, of the conditions which confront the electrical and gas companies of many big cities.

Much interest was taken in the report submitted by Henry L. Doherty, of Denver and New York, on "The Relations Between Manufacturers and Central Station Companies." Charles L. Edgar, chairman of the committee on standard rules for electrical construction and operation made a report on the work accomplished by his committee. Following the reading of the reports the election of officers was held and the business part of the convention ended.

The value of advertising as a legitimate and necessary feature of the lighting industry was prominently brought out during the convention. Every supply house had representatives and exhibits in the city, and the Denver Gas & Electric Company prepared an elaborate display of its varied, unique and effective advertising material. This display occupied several rooms in the Brown Hotel, and excited a great deal of favourable comment from the visitors.

John Craig Hammond, manager of the advertising department of the Denver Gas & Electric Company, was asked by President Davis to discuss advertising methods as applied to the gas and lighting industry. He told of the wonderful success resulting from the liberal and judicious advertising done by the Denver company, and said that, in his opinion, a vigorous advertising spirit was necessary to the success of any company. He pointed out that the advertising and soliciting should be worked harmoniously together in order to secure the best results. They were inter-related, and when the combination became as nearly perfect as possible no influence for the success of a company could be greater.

Arthur Williams paid Denver a high compliment for its new ideas in lighting during this discussion, and reiterated the statement of Mr. Hammond that the soliciting and advertising departments should work together in order to secure the best results in the new business field. The discussion was participated in by the various advertising managers in the convention and nearly all the general managers. Even the small lighting companies, through their representatives in the convention, laid stress on the importance of advertising to bring new business.

Denver took off its coat, as it were, to make it pleasant for the delegates. All of the employees of the Denver Gas & Electric Company, supported by the public-spirited citizens of Denver, did everything in their power to make the stay of the delegates enjoyable and entertaining. Early in the week the delegates and their friends were taken to Elitch's Gardens, where they enjoyed the performance of "Pretty Peggy."

On Wednesday afternoon, June 7, the entire party was taken to the Denver Athletic Club grounds, where the worst bronchos in the West were gathered. Expert cowboy riders were present and treated the delegates and their friends to remarkable exhibitions of feats of horsemanship.

On Thursday evening, June 8, Cook's Drum Corps serenaded the party in the lobby of the Brown Hotel, where the headquarters of the association were located.

On Friday morning, June 9, two special trains took the members of the convention to Colorado Springs. They had been entertained by Denver to such an extent that they were well-nigh ready to admit that anything might be the next thing. But Denver had been compelled to resort to artificial means,—the entertainment was made to order.

Beginning with their arrival at Colorado Springs the delegates turned

DENVER—SEVENTEENTH STREET, SHOWING SOME OF THE CITY'S OFFICE BUILDINGS

to the natural,—the wonderful natural that only Colorado can offer in all of its grandeur and beauty. With clear skies as the setting for majestic and mysterious mountains at the background of one of the most beautiful cities in the world, the delegates drew long breaths of air rarified at an altitude of more than 6000 feet. Then they were ready for the show,—Nature's display.

Friday afternoon was spent in sight-seeing expeditions to the country about Colorado Springs. Carriages were provided, and the delegates were driven through the Garden of the Gods, up Cheyenne Canyon, and over several of the roads that penetrate into the heart of the Rockies without being far distant from civilization.

Many of the members, together with ladies, went to the golf links of the Town and Gown Club, links such as they had never before seen. Others visited the power houses,—one of them a steam plant located at the mouth of a coal mine; another one of the most costly installations in the world, the water-power plant at the foot of Pike's Peak, operating at a head of 2300 feet.

In the evening the delegates were the guests of honour at a dance at the Broadmoor Casino,—a country resort near Colorado Springs, famous in all sections of the country for its location and the beauty of its grounds. There the leading citizens of Colorado Springs met the delegates and gave them welcome.

Some were tired on Saturday; others arose with a sigh from the enjoyment of untrammelled sleep induced by the cool, bracing air from the majestic Pike's Peak and his fellows. But, figuratively, the bugle call was sounded, and it was necessary to be "up and doing" to keep up with the pace that had been set by the entertainers.

A trip to Cripple Creek, the greatest gold mining camp in the world, was the entertainment for Saturday, June 10. Three special trains had been provided, and the delegates were taken in charge by committees, each car having a sufficient number of entertainers to explain to all the many points of interest.

The specials climbed the hills above Colorado Springs, winding and twisting about. Below them, Colorado Springs gradually assumed the form of a dense park of trees and shrubbery, then it resolved itself into a checker-board arrangement that had the appearance of a plan of the city. The clear air left every detail plain to the eye, and the visitors looked down and out from the great peaks that surrounded them, until, with the suddenness of the closing of a door the trains plunged into the heart of the mountains, and left only snow-covered peaks and beautiful valleys and parks within the range of vision.

A short time after, the trains, skimming along the tops of the ridges of mountains, afforded a view of Cripple Creek and the surrounding district from which vast sums in gold have been taken. The city lay far below the steadily puffing trains, but the incline was descended quickly, and the visitors, just finishing a buffet lunch that had been served on board the trains, left the cars to see the sights of the great camp.

Only a brief stay was made in Cripple Creek proper. The trains carried the guests through the great district to Victor. At this point time was given for descent into and inspection of some of the greatest mines in the world. The return trip was made under the rays of the glorious western sun, making his exit amid the glistening peaks of the backbone of the continent.

Entertainment on Saturday night was informal. All of the clubs were thrown open to the visitors and delegates, and again the people of Colorado Springs turned out to aid in the entertaining. Dinner parties were given, and in many homes were small parties.

On Sunday the Colorado Springs committee provided more pleasure for the visitors. Each was taken on

AT THE SUMMIT OF PIKE'S PEAK.

drives that he could not take on Friday because of the lack of time. Care was taken that each saw everything that was to be seen and had ample time to admire the natural beauties.

Many of the delegates joined a special party that was made up to visit the Royal Gorge on Monday, June 12. Others returned to Denver to take trips over some of the famous mountain lines leading out from that city. Still others visited other cities of the State. Scores returned to Denver for the purpose of rest and recreation preliminary to resuming their journey homeward.

The following is a partial list of those present representing central light and power stations:—

Albany, N. Y.—B. E. Morrow.

Albany, Ore.—Jos. H. Ralston.

Albuquerque, N. M.—W. S. Iliff, C. K. Durbin.

Alliance, O.—D. W. Low.

Altoona, Pa.—E. B. Green, J. Doss.

BROADMOOR CASINO, COLORADO SPRINGS, OPENED ITS DOORS TO THE VISITING MEMBERS AND GUESTS

Anaconda, Mont.—Herbert McNulta.

Arrowhead, Col.—William Rush.

Atlanta, Ga.—G. W. Brine.

Baker City, Ore.—F. N. Averill.

Beatrice, Neb.—A. G. Munro.

Beaumont, Tex.—Geo. E. Carroll.

Beloit, Kan.—S. T. Rodgers.

Bethlehem, Pa.—C. M. Walton.

Birmingham, Ala.—J. M. Bradley, J. M. Ritson.

Bloomington, Ill.—C. F. Snyder.

Boise City, Idaho.—J. W. Cunningham.

Boston, Mass.—W. P. Hancock, Irving E. Moultrop, W. H. Gardner, Charles H. Hodkinson, P. A. Brown.

Boulder, Col.—T. H. Schaefer, William F. Smith, O. P. Patterson, Paul E. Temple, E. J. Temple.

Bridgeport, Conn.—W. T. Oviatt.

Butte, Mont.—H. W. Turner, R. C. Kempy.

Cambridge, Mass.—Walter R. Eaton.

Canon City, Col.—William T. Wallace.

Chattanooga, Tenn.—Byron T. Burt.

Cheyenne, Wyo.—D. F. Miner.

Chicago , Ill.—Jno. F. Gilchrist, Louis A. Ferguson.

Cleveland, O.—Samuel Scovil, S. C. D. Johns, M. E. Turner.

Colorado Springs, Col.—George B. Tripp, T. P. Bray, Ira A. Miller, D. Kennedy, Robert J. Clark, Stephen

Connoly, M. V. Watson, E. P. Dillon.

Cripple Creek, Col.—Henry A. Goodridge.

Crookston, Minn.—Ed. Peterson.

De Kalb, Ill.—W. H. Zimmerman.

Demopolis, Ala.—A. R. Smith.

Denver, Col.—Claire N. Stannard, Ross B. Mateer, Geo. Steinwedell, D. M. Coughlin, Frederick Harry, Wm. H. Slavin, A. J. McMullan, Milan R. Bump, John T. Brady, V. A. Henderson, C. W. Kopleman, G. E. Williamson, B. Von Pontious, C. W. Humphrey, N. Miner, H. Zimmerman, Raymond Page, Geo. W. Bixler, H. H. Stevens, John C. Hammond, Edwin Wagoner, J. T. Connors, Duncan T. Campbell, F. A. Tewksbury, Frank C. Farrar, Thos. S. Richardson, Thos. F. Kennedy, J. F. Dostal, H. E. McGee, Wm. P. Risley, N. D. McPhail, H. C. Porter, A. Von Dachenhausen, W. C. Roberts, H. S. Russell, E. S. Taylor, Elmer Jackson, H. M. Taylor, Frank Frueauff, Edward P. Gartland, G. T. Pollard, R. G. Griswold, Ross F. Bump, Rufe Gentry, A. E. Reynolds, S. Tully Wilson, A. E. Reynolds, S. S. Campbell, G. T. Cogswell, H. B. Montgomery, Geo. Putnam, J. W. Proffitt, L. A. Reinert, Herbert W. Courville, S. A. Sewell, Geo. A. Hamilton, J. E. Harsch, W. J. Barker, R. B. Sullivan, Harry Hughes, R. H. Frazier, E. C. Means, T. R. Hopkins, T. K. Gerity, G. M. Karshner, John M. Connelly, Mrs. E. Y. Sayer, Geo. F. Willard, Chas F. Heywood, J. Murray Weed, Cyrus Oehlmann, Roy Monroe, Howard Lockwood, Ph. D. Gleason, Henry Colburn, Wilson Carter, Irving Hale, Philip Cross, B. B. Root, Francis Ridley, W. F. R. Mills, O. B. Kohl, G. F. Bartlett, Mrs. John McGowan, Harry D. Frueauff, S. W. Cantrill, G. L. Coggswell, Jno. W. Miner, Jr., David M. Knox, A. R. Hall, J. P. Risley, H. R. Dodson, Jno. Braman, Odell M. Brown, A. M. Ballou, C. A. Trease, E. H. Pigeon, C. A. Johnson, W. C. Nollenberger, Harry R. Whitehead, W. A. Mahoney, J. A. Beeler, J. G. O'Brien, A. C. Anderson, Fred. S. Hartzell, W. E. Comer, F A. Woodworth, Henry A. Tewksbury, C. E. Snell, Geo. S. Pearson, H. E. Smith, T. R. Ritchie, Ira L. Preston, John W. Bantsch, A. A. Blakely, Chas. E. Pendleton, C. G. Keeler, F. L. Lindsley, Frank L. Cummings, L. D. Grim, W. D. Kesselring, Chas. E. Shimes, H. C. Hefner, Walter W. Martin, Wm. I. Moeller, Mrs. K. L. Moeller, Joseph Fugazzi, Glen Wilson, Hugo Feich, R. M. Staley, F. Brederlin, J. R. Huster, Jas. L. Stone, L. E. Wright, A. C. Bristol, Henry Frankel, Charlie E. Addie, Chas. Zuber, Wm. Lembach, Jas. Daily, Lloyd Shubert, Clifford Brown, Robert B. Jackson, G. F. Pease, H. S. Truesdell, Flora W. Evans, C. J. Caldwell, Phelps Buell, B. W. Evits, B. M. Lee, Joseph A. Bantsch, W. H. McAloney, Charles Tomlinson, J. G. O'Bryan, Robert B. Bonney, J. G. Sayler, B. H. Lynch, D. Lee Farrow, J. W. McDonough, Harry C. LaSalle, Frank H. Love, Dwight Johnston, A. S. McCormac, Clarence Keeier, L. H. Martin, E. I. Clyne, P. J. Monahan.

Des Moines, Ia.—R. H. MacMullan.

Detroit, Mich.—Alex. Dow, Hoyt Post.

Duluth, Minn.—C. E. Van Bergen.

Durango, Col.—A. Peters.

Eldora, Ia.—W. S. Porter.

El Paso, Tex.—H. P. Scott.

Evanston, Wyo.—F. Beckwith.

Evansville, Ind.—W. B. McDonald.

Excelsior Springs.—J. E. Lindstrom.

Fall River, Mass.—Albert F. Dow.

Florence, Col.—Chas. Neely.

Fort Collins, Col.—H. E. Malcouronne, Nelson Touns.

Fort Smith.—Geo. H. Witmont.

Fort Wayne. Ind.—C. G. Guild.

Fulton, N. Y.—L. W. Emerick.

Georgetown, Col.—Chas. J. Dewey.

Golden, Col.—M. T. Morrill.

Grand Forks, N. D.—Thomas Roycraft.

Grand Island, Neb.—Charles E. Newton, O. P. Sells, J. C. Kenly.

Greeley, Col.—Wm. Mayher.

Green River, Wyo.—Geo. H. Maxam.

Guthrie, Okla.—Galen Crow.

Hartford, Conn.—A. C. Durham, R. W. Rollins, Henry F. Smith.

Hillsboro, Ill.—Geo. T. Kester, J. J. Frey.

Holton, Kas.—W. E. Gant.

Hot Springs, Ark.—J. E. Cowles.

Humboldt, Ia.—C. H. Brown, Jr.

Jersey City, N. J.—W. W. Titzell.

Kearney, Neb.—L. E. Watson.

Lafayette, Ind.—C. H. Vinton.

Lamar, Col.—Donald E. Bent.

Leadville, Col.—Chas. Borttcher, F. C. Webber.

Leavenworth, Kan.—Mrs. W. H. Fellows, W. H. Fellows.

Lewiston, Pa.—E. F. McCabe.

Lincoln, Neb.—L. E. Hurts, Jas. S. Dales.

Littleton, Col.—Wm. C. Sterne, E. C. Sterne.

Lockport, N. Y.—Oliver M. Diall.

Los Angeles, Cal.—R. H. Ballard, A. L. Selig.

Louisville, Col.—Jas. H. O'Hern.

Loveland, Col.—Ed Ridley.

Madison, Wis.—E. W. Hale, Chas. A. Frueauff, George Little.

Marcelline, Mo.—Ger. W. Earle.

Marlboro, Mass.—H. E. Ryder, George A. Highway.

Marysville, Kan.—J. E. Lindstrom.

Massillon, Ohio.—W. E. Russell.

Memphis, Tenn.—S. T. Carnes.

Meriden, Conn.—Chas. A. Learned, Samuel S. Gleason.

Mobile, Ala.—J. H. Wilson.

Morristown, Pa.—D. A. Bertolette.

Mount Vernon, N. Y.—J. T. Cowling.

Muncie, Ind.—W. F. Warner.

Newark, N. J.—Dudley Farrand, Ed. J. Allegaert, Harry P. Chandler, John J. Gaffney, Percy Ingalls, P. S. Young, C. W. Lee, Paul, Lupke.

New Bedford, Mass.—Geo. R. Stetson.

Newton, Mass.—Welles E. Holmes, F. Murdock.

New York, N. Y.—B. K. Sweeney, Arthur Williams, N. F. Brady, Henry L. Doherty.

Niagara Falls, N. Y.—Joseph E. Montague.

Nyack, N. Y.—J. S. Avery.

North Tonawanda, N. Y.—A. S. Allen.

Oak Park, Ill.—F. S. Richmond.

Ogden, Utah.—Paul R. Shipley.

Omaha, Neb.—John Harmon, S. E. Schweitzer.

Ontario, Cal.—E. W. Paul.

Orange, N. J.—Warren Partridge.

Ottawa, Ont.—John Murphy.

Ouray, Col.—S. S. Thompson.

Pawtucket, R. I.—Orin Smith, Jr.

Peoria, Ill.—R. L. Wallace.

Philadelphia, Pa.—A. J. DeCamp, H. T. Hartman, William C. D. Elgin, Wm. P. Conover.

Pittsburgh, Pa.—R. S. Orr, E. Uhlenhaut, Jr., Mrs. F. Uhlenhaut, Jr., F. Uhlenhaut, Henry F. Cogshall.

Pittsfield, Mass.—Wm. R. Gardner.

Plainfield, N. J.—R. P. Bache.

Pontiac, Ill.—J. A. Carothers.

Provo, Utah.—J. J. Nunn.

Pueblo, Col.—John F. Vail, H. N. Gilbert, E. J. Spriull, C. M. Wright.

Quebec, Canada.—H. C. Abell.

Quincy, Ill.—W. A. Bixby.

Rawlins,—Wyo.—Julian B. Downey.

Red Oak, Ia.—D. F. McGee.

Richmond, Ind.—J. W. Roney.

Rock Springs, Wyo.—L. D. Gray.

Saginaw, Mich.—H. L. Brintnall.

St. Joseph, Mo.—C. F. Hewitt.

St. Louis, Mo.—O. M. Rau, W. C. Underhill

St. Paul, Minn.—Paul Doty, Henry J. Gille.

Salina, Kan.—G. H. Smedley.

Salt Lake City, Utah.—M. C. Godbe, O. A. Honnold, R. F. Hayward.

Seattle, Wash.—W. H. Blood, Jr.

Shenandoah, Ia.—G. F. Morse.

Sheridan, Wyo.—E. C. Butler.

Sioux City, Ia.—C. C. Garland.
Springfield, Ill.—A. V. Schroeder, R. C. Lanphier.
Springfield, Ohio.—C. S. Johann.
Syracuse, N. Y.—E. B. Doen.
Telluride, Col.—S. R. Fitzgerald, C. G. Breck.
Terre Haute, Ind.—Chas. T. Mordock.
Toledo, Ohio.—E. J. Betchel.
Topeka, Kan.—C. R. Maunsell.
Trinidad, Col.—D. S. Harper.
Tucson, Ariz.—O. S. Moore.
Utica, N. Y.—M. J. Brayton.
Victor, Col.—W. N. Clark, Miss Sue Clark, A. S. Cooper.
Walla Walla, Wash.—R. E. Allen.
Washington, D. C.—H. W. Fuller, L. E. Sinclair.
Wayne, Pa.—John L. Mather.
Weatherford, Tex.—S. O. Newton.
Welch, W. Va.—Norman C. McPherson.
Westchester, Pa.—Jas. E. Pyle.
Williamsport, Pa.—E. H. Davis.
Winona, Minn.—A. G. Moser.
Youngstown, Ohio.—E. H. Bell.

Electric Lighting Legislation in New York State

A RECENT bill passed by the New York Legislature fixes the price of electric light to private consumers in New York City at 10 cents a kilowatt-hour. In Kings County, virtually the borough of Brooklyn, the price may be 12 cents. The price for municipal use, outside of street lamps, is on the same basis. For electric street lamps the price is $100 a year for 450-watt lamps, $90 for 325-watt lamps, and $65 a lamp where two are on a single pole. That part of the Borough of the Bronx lying east of the Bronx River is exempt from these prices.

A bill has also been passed creating three offices to be known as Commissioners of Gas and Electricity. These will have offices in Albany, New York and Buffalo, and must meet at least once a month in the first-named city. They will have supervision of all gas and electric light, heating and power companies, and may fix the standard and pressure of the gas. The mayor of a city, village trustees or a town board representing 100 customers may demand an investigation as to quality and price of the light, and the commission is given power to enforce its orders.

According to statistics compiled by the United States Geological Survey, the total quantity of sheet mica produced in the United States during 1904 was 668,358 pounds, valued a $109,462.

Electrolytic Copper for Automobile Radiators

A METHOD of making automomobile radiators of copper electrolytically deposited is described in "The Automobile," of recent date. A fusible metal pattern is first made, and this is put through the usual process of electroplating. When a sufficient thickness of copper has been obtained, the whole is heated and the fusible core runs out, leaving, however, a thin coating on the inside of the copper shell.

Unsolved Problems in Electrical Engineering

IN recently discussing unsolved problems in electrical engineering before the British Institution of Civil Engineers, Col. R. E. B. Crompton divided them into two groups—those given by Nature herself, and which chiefly concern the scientific investigator, and those which have presented themselves to engineers since they began to use electrical energy for man's service. An engineer is only concerned with Nature's problems so far as their investigation comes into his work when he is called upon to provide means to protect works from damage due to the display of Nature's electrical forces.

In the first group protection against lightning is dealt with. Atmospheric discharges, said the author, appear to be the cause not only of damage to bodies on or above the earth's surface, but also of many mysterious perforations of the insulation of underground cables.

Another problem is to find to a certainty whether the magnetomotive force which produces the earth's magnetic field originates within the earth itself or externally to it. The etheric transmission of power and a better method of originating a continuous train of waves rather than intermittent ones for signaling is another problem presenting itself.

Under the second group of problems are those of the development of electrical machinery. Those problems relating to the designs and construction of the most efficient magnetic fields have been met with in the entire stage of development. The effect of the form of coil winding on heating or reducing the bulk, weight and cost of the copper should be studied. As to insulation, a non-hygroscopic and acid-proof material should take the place of a fibrous one.

The storage battery is also susceptible of improvement, especially one for portable use. Other problems mentioned by the author were electric traction, the perfecting of measuring instruments, the further utilization of electrical energy for the purposes of our daily life, a direct method of producing cold from electrical energy in the supply mains—this is perhaps a problem for the electro-chemist, as the apparatus might take the form of a battery absorbing heat from the surrounding air—and the dispersing of fog and collecting dust by communicating static discharges to the air.

Increase in the Use of the Electric Drive in Textile Mills

AT the recent convention of the New England Cotton Manufacturers' Association, S. B. Paine said that, on a conservative estimate, 175 textile mills in the United States are using electrically about 140,000 H. P. The first textile mill was electrically equipped in 1894.

The census of 1900 showed that 1,165,048 H. P. was used by the cotton, woolen, worsted and silk mills in the United States. Assuming an increase in the last five years of 25 per cent. we find that about 10 per cent. of all the power used in these industries is obtained from motors. When we consider the fact that, at the outset, the electric system was as new to engineers as to the manufacturers, we can understand why the progress has not been even more marked.

It may be of interest to analyze 90,000 H. P. of the above of which record has been kept in detail. Of this amount 54,000 H. P. is generated by steam, 33,000 H. P. by water-power and about 3000 H. P. by water and steam combined. Forty-two new mills have been built in which the electric drive was adopted at the outset. In 28 of these 42 mills, the energy is generated by steam and in 14 by water-power.

Most significant, however, is the large number of mills which are operated from central power stations. Twenty-two mills are thus driven entirely by current generated by an outside and independent corporation, while the same number purchase 5586 H. P. to supplement the power generated upon the premises.

After a recent trip from Liverpool to New York, the steamer *Campania* reported that when in midocean the vessel was in communication by means of wireless telegraphy with both America and Europe simultaneously, a feat never before accomplished.

Protection from Lightning and Other Static Disturbances

By ALEX DOW and ROBERT S. STEWART

A Paper Read at the Recent Denver-Colorado Springs Convention of the National Electric Light Association

THIS report is intended to be a brief of present practice, with notations. It does not present any new theories or devices.

PRELIMINARY

Lightning arresters were built on a kind of "hit-or-miss" plan until Dr. Lodge showed that lightning discharges differed from static discharges in magnitude only, the same laws governing both. When this was recognized the manufacturing companies carried out exhaustive tests with static machines on various protective devices, and in this way developed protective apparatus that could not have been designed had it been requisite to make all tests on live lines during thunder storms.

After long tests with static machines had indicated the best general designs the apparatus was put into actual service in places where thunder storms were unusually severe. Many minor changes have been and are still being made, due largely to the changes in the kind of apparatus to be protected, but the main features of the standard arresters have not been changed in many years.

DUTY OF LIGHTNING ARRESTERS

Transmission lines are occasionally subjected to excessive high-potential strains that would be injurious to generators, transformers or motors, and it is the function of a lightning arrester to protect the apparatus from such strains. These excessive strains are due to the following:—

1. Lightning. During a storm, if the potential difference between two clouds or between a cloud and the earth becomes excessive, a disruptive discharge occurs. This discharge is usually oscillatory, the frequency of the oscillations being very high. Induced currents are set up in all the surrounding conductors, even when they are several miles distant. Lines are seldom struck by a direct stroke of lightning, and the damage is not necessarily serious, if the line is struck some distance from the station, for the line chokes back the discharge. Poles are split by the lightning traveling down them instead of following the line into the station.

A good example of the action of a direct stroke was observed in Detroit some years ago. One of the street-lighting towers was struck in the daytime, when no current was on the lines, the latter being thoroughly grounded at the station a mile away. As the tower was of iron, the main portion of the discharge evidently traveled down this to earth. Two of the switches at the top of the tower were burned out, the current jumping from the tower to the line, the auxiliary cut-out in one of the lamps was raised and the contacts welded together, showing that a very large current had flowed through this contact. This current then traveled down the line wires to the base of the tower and jumped to the case of the switch at the bottom and from thence to earth. Current also traveled down all four guy lines, splintering all the guy stubs. To one of these stubs a guy line was fastened to a telephone pole. A portion of the current jumped to this line and from there to a trolley wire, puncturing the insulator on the hanger. Nowhere else on the line was there any evidence of damage.

The damage sequent to a lightning discharge is in most instances the work of the induced currents set up in surrounding or adjacent conductors. The potential strain is usually from the line to earth, but may be, and frequently is, between the several wires of a circuit. This latter is more likely to be the case on lines in which the wires are strung some distance apart.

2. High-frequency waves set up by sudden changes of load or by resonance. These waves are similar to the induced currents from lightning, but the frequency is not so high, nor is the potential difference as great. The maximum strain is almost always between the several wires of the circuit.

3. Static charges. A line insulated from the earth may become charged to a high potential if the climatic conditions are favorable. A very dry atmosphere, hot-wind storms, sand storms and great variation in the altitude of the pole lines are some of the causes of static charges. During severe sand storms the arresters may not be able to keep down the potential of the line, although they may be discharging almost continuously.

METHODS OF PROTECTION

The best methods of protection are as follows:—

1. Non-inductive high resistances connected from the circuit to the earth.

2. Lightning arresters. These should have enough resistance in series with them to prevent the discharges from becoming oscillatory.

3. Overhead ground wires, as described later.

ESSENTIAL FEATURES OF PROTECTIVE APPARATUS

1. They should discharge at a potential slightly higher than that of the system.

2. The ordinary working of the system should not be affected by the discharge.

3. The electric energy of static disturbance should be dissipated as rapidly as possible.

4. The static waves should be prevented from developing high-potential difference in generators, transformers and other apparatus.

An ordinary spark gap from the line to earth fulfills the first condition perfectly. The gap can be set to break down at any voltage desired. A spark gap is dispensed with altogether in some arresters, the line being connected to earth through a non-inductive resistance which is high as compared with the resistance of the rest of the circuit. Water jet and tank arresters are examples of this.

The gap once broken down, the line current will follow unless some means is adopted for preventing this. Inserting resistance in series with the gap, subdividing the gap into several smaller ones, making the metal cyl-

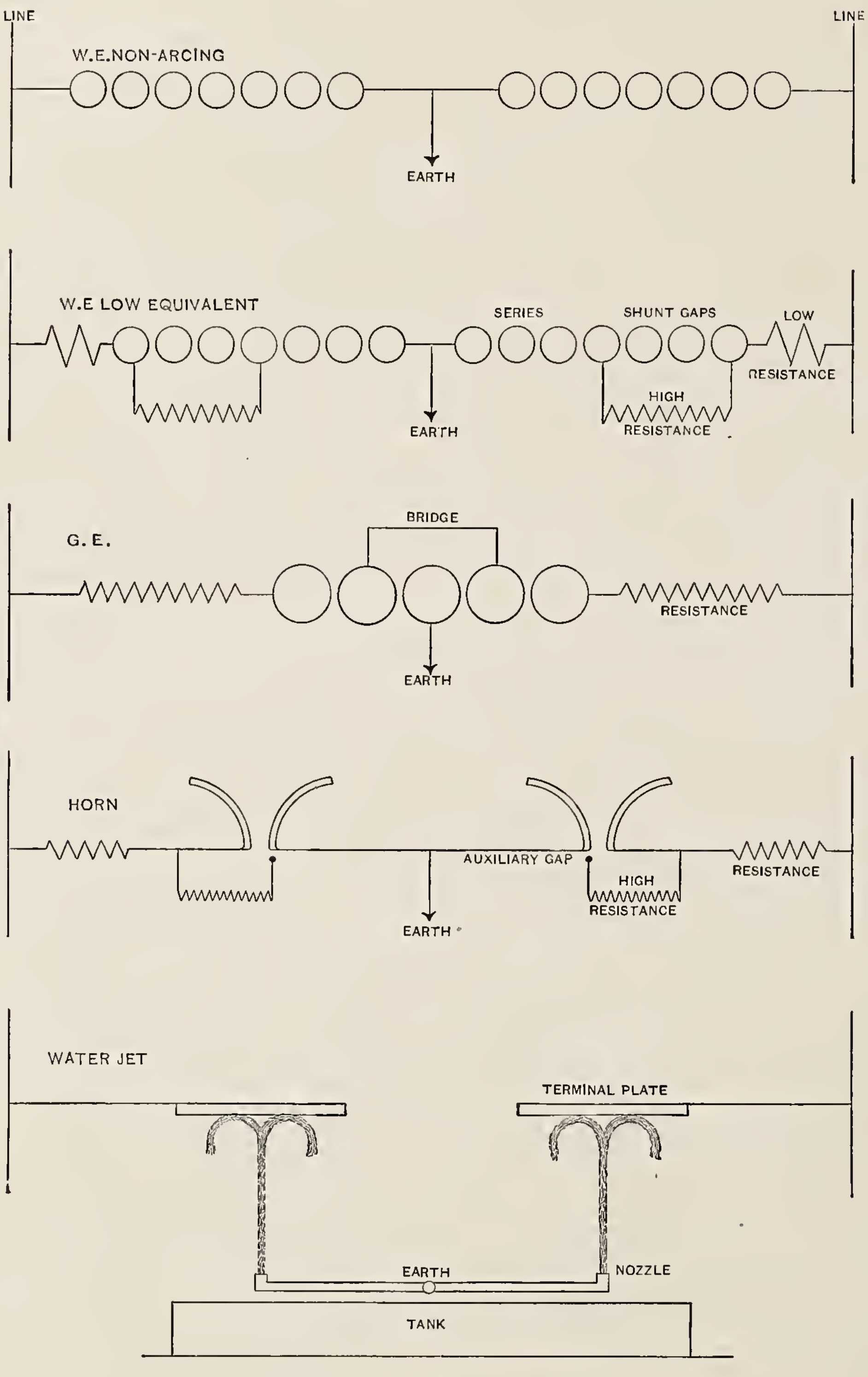
inders between the gaps of some non-arcing material, increasing the size of these cylinders so as to present a large cooling surface for the arc, and blowing out the arc by a magnet are the methods adopted at present.

The third condition is very hard to comply with, as static disturbances differ so much from one another. To protect from a direct stroke of lightning, as little resistance as possible should be in circuit. If, however, the line is charged with static electricity, oscillations will be set up in the line when the arrester discharges, unless a certain amount of resistance is in the circuit.

The fourth condition requires the use of choke coils for disturbances due to lightning, or combinations of choke coils and condensers for static waves due to short-circuits and other sudden changes of load.

DESCRIPTION OF THE MAIN PARTS OF STANDARD ARRESTERS—ALTERNATING CURRENT

General Electric Arrester for 2000 Volts.—Two 1-32-inch air gaps are connected from line to earth in series with a non-inductive high resistance. Cylinders are large, to give a large cooling surface for the arc. The current is kept low by the high resistance used. For protection from stresses between the separate wires of line, half of the gaps are cut out by a bridge connecting the two cylinders, which are midway between the line and earth. The arrester thus connected will have the same number of gaps between the lines as from the line to earth. For very high-voltage systems several arresters are connected in series. This arrester should protect very well from ordinary disturbances, but the high resistance does not permit of rapidly dissipating the large amount of energy in a lightning flash.



LIGHTNING ARRESTER DIAGRAMS

Westinghouse Arrester for 2000 Volts.—Six 1-32-inch air gaps are in series from line to earth. Cylinders are made of non-arcing metal. No resistance is used with this when connected to lines fed by 2200-volt generators of moderate size. When a higher potential than 2200 volts is used more gaps are used and a resistance is connected in series with the arrester to prevent an excessive current from the generator flowing through the arrester. This arrester protects from severe flashes very well, but as length of air gap is longer than in the General Electric arrester, a higher difference of potential is required to break down the gap. On discharging a line that has a static charge, oscillating waves may be set up in the circuit, since no resistance is used.

These two arresters show how differently two companies will sometimes reason in designing apparatus for the same service.

Westinghouse Low-Equivalent Arrester.—This was designed about five years ago in order to cut down the number of gaps required in the standard arrester when used on very high-voltage circuits. It consists of a small number of gaps which should break down at a little above the line voltage. In series with these is a high resistance, and shunted across this resistance is a second set of gaps equal in number to the first set. In series with the whole arrester is a small non-inductive resistance, to keep down the main current. Non-arcing metal is used for the cylinders. The operation is as follows:—If the potential of the circuit increases, the series gaps break down immediately. As the resistance of these gaps when broken down is small compared with the high resistance in series with them, practically full-potential strain is put on the gaps shunted across this resistance and they will break down. After the static discharge the arc immediately dies out in the shunted gaps if the arrester is properly designed, and the high resistance cuts the current so low in the series gaps that the arc in these is next extinguished. This arrester combines the good qualities of both those already described, for it furnishes a high-resistance path for small static discharges and a low resistance for violent discharges.

It was the privilege of one of the writers to install the first of these arresters. A considerable amount of lightning trouble had been experienced with a high-voltage generator,

several generator coils and a transformer having been burned out in a single year. The generator always ran through heavy thunder storms, but a little lightning anywhere along the line would cause trouble. The trouble was always due to short-circuits, the discharges never going to earth except through the arresters. The arresters were changed by shunting part of the gaps by a high resistance. No trouble had been reported from this plant three years after this change was made.

Horn Arrester.—This consists of a single large gap, the sides of which are horn-shaped metal pieces to which iron pieces are fastened. The theory of the arrester is that the discharge across the gap sets up a magnetic field, which is distorted by the iron pole pieces. This field draws up the arc following the discharge to a point where the field will be symmetrical around the arc. At this point the gap will be so long that the arc will be extinguished, provided the current through the arrester is kept low by a non-inductive resistance. When used on very high-voltage systems the air gap has to be very large to prevent excessive current across the gap. To remedy this fault a small auxiliary gap and a high resistance are shunted across the main gap. When a discharge occurs across the auxiliary gap the heat of this starts an arc across the main gap. This would seem to be a defect, for by the time the arc had started across the main gap all the damage might have been done by the static wave. The reports concerning this arrester are too meagre for us to judge of its operation. It is used on several lines in Europe, but has been tried very little in the United States.

Water Jet Arrester.—Water jet discharge devices have been used on some of the high-voltage transmission lines in Europe, and are reported to be operating very satisfactorily. Jets of water are thrown from a grounded nozzle against terminal plates connected to the several wires of the circuit. These columns of water furnish high non-conductive resistance paths from the line to earth for any static waves. The power lost is said to be about three kilowatts, and the water used less than one gallon per minute. It would seem that the resistance of the water columns must be so high that it could not dissipate the energy of a violent disturbance with sufficient rapidity.

DIRECT-CURRENT ARRESTERS

In direct-current service the arc formed by a discharge is much harder to extinguish than in alternating-current service. Fortunately, however, direct-current voltages are usually small.

Thomson Magnetic Blow-Out Arrester.—In this the single air gap is between two metallic horns. An electro-magnet is placed with its poles opposite the lower extremity of the gap. This magnet is excited either by the discharge current or by the main-line current. The magnetic field set up blows out the arc immediately. The operation of this arrester is very satisfactory.

Westinghouse Direct-Current Arrester.—This is built in accordance with the principle that if the voltage across a gap is very low no arc will be maintained in the gap. A large number of minute gaps are connected in series. Carbon particles are used to form the sides of these gaps. It is necessary in this arrester to keep the lines of carbon particles protected from the air, or an arc will be carried across the air above the carbon and will burn up the arrester. The objection to this arrester has sometimes been made that its operation has to be taken on faith. There is no evidence of discharge unless one is observing the arrester at the time of discharge. Tell-tale papers in a small auxiliary gap connected in series with the arrester would be advisable.

Garton Arrester.—Two gaps are connected in series with a non-inductive resistance. Shunted across part of this resistance is a small coil. On discharge, the current in the coil lifts an iron armature, and increases the length of one of the gaps so much that the arc is immediately extinguished. The most serious objection to this arrester is that it contains moving parts. If a second static wave follows immediately after a first, the air gap at this time will be so long that no discharge can occur, and the apparatus on the line may be subjected to a dangerous potential.

Westinghouse Tank Arrester.—This was designed many years ago for the protection of large railway stations. Instead of air gaps, a tank of running water is connected directly from the line to ground. The current taken will be small in comparison with the load. The arrester is disconnected from the circuit, except during thunder storms.

CHOKE COILS

With all arresters choke coils are placed between the arrester and the apparatus to be protected. A coil of wire offers opposition to the passage of an electric discharge through it. The more sudden the discharge the greater will be the opposition. The opposing e.m.f. in the choke coil may be so high that the path across the air gap of an arrester will be easier than through the coil. In the case of lightning the discharges are either very sudden or they are oscillatory discharges of very high frequency, and a coil which offers practically no opposition to the main current is sufficient. The potential at a choke is greater than it would be if the coil were not present, for the potential is the resultant of the advancing wave and of the wave that is reflected by the coil. This resultant will always be greater than that of the advancing wave alone. It is standard practice to divide a choke coil into several parts and to place arresters between these so as to furnish paths to earth for any discharge that has passed the first arrester.

DISTRIBUTION OF ARRESTERS

In long-distance transmission the lines need no protection, and the arresters are grouped at the two ends of the line. Several choke coils are used, and the arresters are connected to the line at several places between the coils, so as to be sure that some of the arresters will be at a maximum point of a static wave. In distribution networks, arresters should be scattered all over the network. There is no general rule as to the number necessary, except that the more arresters installed the better the protection.

In low-voltage networks that are tied together in many places, if one branch extends some distance from the network, weak spots near the end of the branch are punctured by discharges during thunder storms. Experiments with static machines and small networks of conductors showed the same phenomenon many years ago. A static wave traveling down the conductor is reflected back at the end of the conductor. The resultant of the advancing and reflected waves gives at the end of the line a potential strain that is double that of the advancing wave.

The remedy is to put choke coils in the branch at the point where it is connected to the network. The wave in the network will then be divided at the coil, part being reflected at this point and only a small part advancing along the branch.

OVERHEAD GROUND WIRES

In many long-distance transmission systems the lines are protected by ground wires strung above the lines. These ground wires are connected to earth every thousand feet.

The theory is that if lightning strikes the line the ground wire would be struck directly instead of the line wires that are insulated from ground. As the earth's potential is above and also below the line wires, these cannot be charged with static to a high potential. The inductive action of lightning on the line is much reduced, as the ground wire is much nearer the line than the earth is.

There is one case in which ground wires are of no service. If the earth and a cloud are charged, the line is charged to the same potential as the earth. If a disruptive discharge occurs, the line, being insulated from earth, is discharged much more slowly, and there may be a great difference of potential between the line and earth. Arresters would be required to protect the line from such strains. A ground wire is also no protection from strains caused by high-frequency waves that are set up in a circuit by sudden changes of load or by resonance.

The result of years of test has been favourable to ground wires in many cases. It is particularly noticeable that on lines provided with ground wires poles are not split by lightning.

Theoretically, barbed wire should be used for an overhead ground wire, as the points of the barbs draw off the charge from the surrounding air. The action is the same as that of the comb in a static machine. In practice, however, there does not seem to be any gain in the use of barbed wire. It is very difficult to string on poles, the points are far from being theoretical points, and the wire is of a poor grade. These disadvantages more than offset the theoretical advantages. A good construction would be No. 8 B. & S. gauge E.B.B. wire, strung on glass insulators and grounded every thousand feet. The two outside pins on the top cross-arm are sometimes used for ground wires, but as the construction is expensive and there is some difficulty in connecting the wires to ground, a single ground wire, either above or below the circuit, is more frequently employed. Glass insulators are used, so as not to subject the pole to any unnecessary electric strain from the line.

CONCLUSION

There is still much to be done before we can claim to have our lines perfectly protected. The engineers of the manufacturing companies have developed apparatus that operates successfully under ordinary conditions, but each transmission line is a separate problem and can only be solved empirically. Complete records of static troubles and, so far as can be determined, their causes should be kept by the different power companies, to show how their apparatus is affected by the local conditions.

The Choice of an Insulated Cable

By WALLACE S. CLARK, of the Wire, Cable and Tube Department of the General Electric Company

A Paper Read at the Recent Denver-Colorado Springs Convention of the National Electric Light Association

EVERY plant generating electric current uses insulated cables, in many cases only for station wiring, in others for its entire distributing system. The company that buys twenty-five or more miles of cable each year can and does devote a liberal allowance of engineering skill to the selection of the best and most economical types. There are a very large number of plants of moderate size that, with the growth of their business and the increasing tendency to substitute underground for overhead construction, are compelled to increase continually their investment in this line.

The size of the conductor is determined by well-known methods, therefore it is only necessary to emphasize some points usually overlooked. There are two distinct conditions of service, one where the amount of current is not subject to any probable increase, such as instrument, generator and transformer leads, the second comprising all lines outside of the station that may be subjected to increasing loads due to the growth of business.

For the first class, ampere capacity, or mechanical strength in the case of small apparatus, is the determining factor. The current-carrying capacities given in the National Electric Code for rubber insulation are a fairly safe guide and the current densities given should not be exceeded. For the second class of conductors, the cost of power at the switchboard, the load factor of the line, the limits of loss in transmission for satisfactory regulation of potential and operation of consuming device, the heating of the cable in short lines, the probable increase in load with time and the interest charge on the cable investment are the principal factors in settling the size of conductor to be used. The Thomson law, so-called, that the most economical arrangement is where the cost of the power wasted and the interest charge on the cable investment is a minimum, is the basis of many formulæ elaborated in different books.

Having determined the size of conductor required on theoretical grounds, consideration should be given one or two very practical points. First, do not use for underground construction cables so small as to be mechanically weak. The writer has in mind a station with a 6600-volt distribution where the cables ran from three-conductor No. 0000 to three-conductor No. 6 in size, the latter constituting the smallest part of the installation and giving more trouble than the entire remainder of the system.

Second, in using a duct system, keep in mind the fact that the cost of duct per foot is independent of the size of the cable in the duct, and select the size of conductors so that the cables will utilize a reasonable proportion of the duct area. Two No. 8 arc-light cables, single-conductor, in a 3-inch duct, and costing from 20 cents to 40 cents per duct foot, are evidently uneconomical. The standard 3-inch duct will take cables of the following sizes, insulated for different voltages:

For any voltage under 1500, single-conductor cables up to 2,000,000 circular mils; concentric two-conductor cables up to 1,000,000 circular mils; three-conductor cables up to 500,000 circular mils. Fig. 1 shows the three types of cables.

For 3000 volts, single conductors up to 1,500,000 circular mils; concentric up to 750,000 circular mils; three-conductor up to 400,000 circular mils.

For 6600-volt lines, which are prac-

tically all three-phase, the limit is found at three-conductor, 250,000-cm. cable; 12,000-volt lines, the limit is found at three-conductor No. 0000 cable; on 24,000-volt lines at about 100,000-cm. cable.

It is assumed, of course, that the three-conductor cables run on delta-connected circuits, and have the same wall of insulation between conductors and ground as between the conductors themselves. If the three-phase circuit is Y-connected with the neutral grounded, then the outer jacket of the three-phase cable can be made considerably less in thickness and larger cables be installed in the standard 3-inch duct.

Fig. 2 gives the variation in cost per 1000 circular mils of copper contained in the cable for different sizes of cables and different working potential. It will be noted that the lack of economy in the use of small conductors is most marked in the 15,000-volt class, where changing the size from No. 8 to No. 6 wire increases the cost less than 4 per cent., while the conductivity is increased 58 per cent. Taking the larger sizes and going from No. 1 to No. 0, the cost is increased 8 per cent. and the conductivity 26 per cent.

These figures and curves are based on varnished cambric cable, as this type of insulation is approximately midway in price between good rubber cable and good paper cable. With paper insulation the comparison would be less favourable to the larger conductors, while with rubber insulation the use of the larger conductors would show much greater economy.

There is another point especially noticeable in the use of potentials above 5000 volts, and that is the safe working pressure for a given thickness of insulation is less in the very small sizes of conductor. To put this another way, where the thickness of insulation exceeds twice the diameter of the copper core in high-potential cables with homogeneous insulation, we are not able to get the full advantage of the insulating wall, since the fall in potential or potential gradient is undoubtedly higher in the layer of insulation immediately adjoining the copper than it is half-way between the copper and the outside of the cable, this concentration of pressure tending to break down first the inner layers of the insulation and finally puncturing the entire insulating wall. In short, it is easier to make a 500,000-cm. cable for 10,000 volts working pressure than to insulate a No. 14 wire for the same purpose.

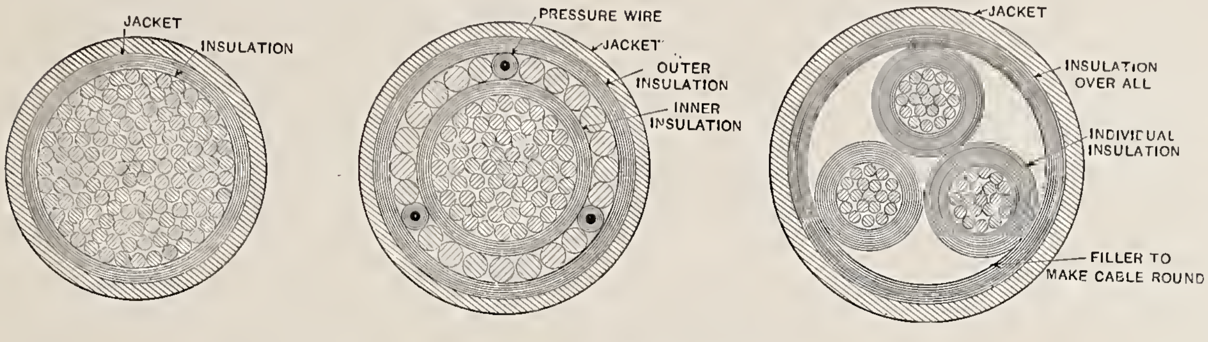


FIG. 1.—THREE CABLE SECTIONS

The next point to be covered is whether single or multiple-conductor cables should be used. For station wiring, single conductors in separate ducts, or runways, might safely be taken as the best modern practice. Maximum safety and reliability and simplicity of arrangement appear to have settled this question quite definitely. For outside lines the service will largely decide. Direct-current railway feeders are normally single-conductor.

When ducts are high in cost and the load on one feeder is not heavy enough to require a cable utilizing most of the duct space, two feeders may be combined, so long as their course is parallel, in a concentric type of cable if it is desirable to preserve their identities to the switchboard. If it is not important to run the cables as separate feeders back to the switchboard, we may bunch two or more cables by means of a junction box into a single large cable, which will run back to the generating plant, as, for instance, three 500-000-cm. cables might be multiplied and a 1,500,000-cm. cable run back to the station. This cable is readily installed in a standard 3-inch duct, and there would be a saving in first cost of cable, in duct investment and in switchboard.

For low-tension mains on the three-wire system, either three single-conductor cables or one three-conductor cable can be used. The three-conductor cable is slightly cheaper in first cost but not nearly as convenient for making taps to customers. Theoretically, with alternating currents there is a slight advantage in the use of the three-conductor cable. For low-tension feeders, which usually exceed 250,000 circular mils in size, the concentric type of cable should be used for maximum duct economy. Smaller than 250,000-cm. cables may be run as a flat twin conductor, and this type is always advisable for alternating-current feeders with manhole transformers. It should be noted here that it is a modern practice, and one to be commended, in running a three-wire system, to ground the neutral and run the feeders simply as two-wire feeders, providing a tree or trunk neutral to which the different points of distribution are connected and which runs

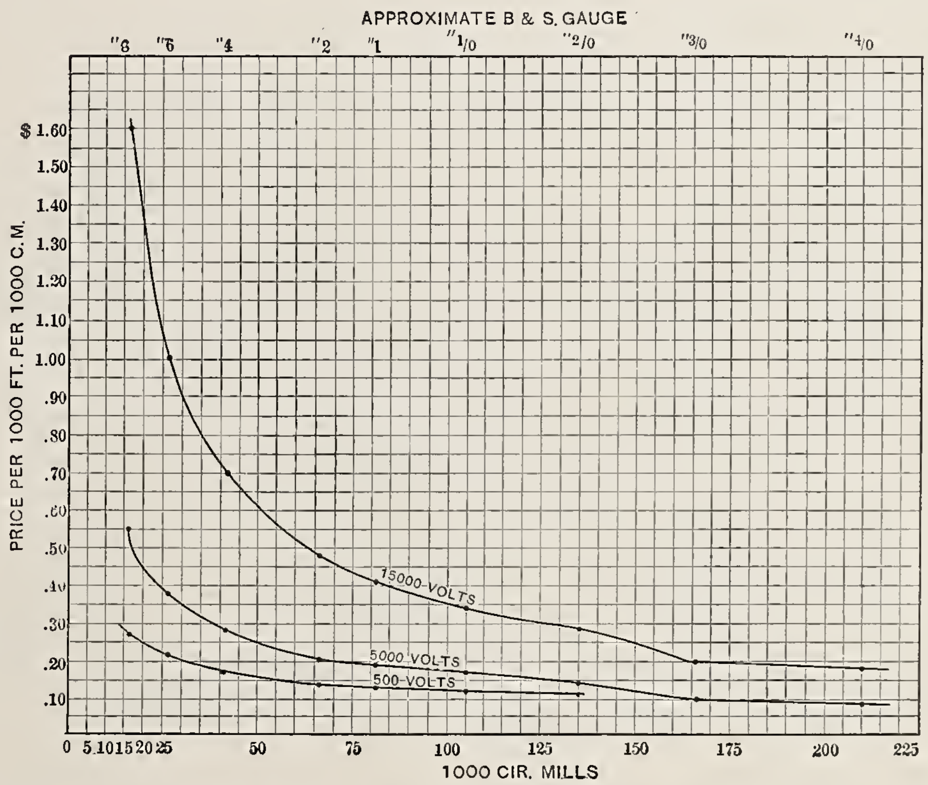


FIG. 2.—VARIATION IN COST PER 1000 CM. OF COPPER FOR DIFFERENT SIZES OF CABLES AND DIFFERENT VOLTAGES

back by means of a very heavy cable to the station.

The common practice in arc circuits is to use single-conductor cable. Where a number of circuits are in parallel for any distance an excellent plan is to combine them into a multiple-conductor cable. This saves in first cost, in cost of installation and of ducts. If a number of small leaded cables are run in one duct, an arrangement necessary in order to keep the duct investment reasonable for the arc circuits, one cable burning out in a duct is very likely to injure the others. Further, the cables are liable to mutual injury when being installed, and it is quite difficult to draw out one cable without damaging the others. These are defects that may be avoided if a multiple-conductor cable is used.

Single-phase, two-wire lines, not exceeding No. 0000 in size, should be run as twin conductors unless numerous taps are made, in which case the greater convenience in making joints may justify the use of the single-conductor cable. The concentric type of cable for single-phase work is losing favour in Great Britain and on the Continent, and has never been in favour in the United States. The most serious objection is that, in a large network of concentric cable on single-phase or three-phase alternating circuits, great care is required in switching, since the outer conductor has a very much higher electrostatic capacity to earth than the inner conductor, giving rise to surging of the voltage and current and to burn-outs. For three-phase work, three-conductor cables, and for two-phase (quarter-phase), four-conductor cables are required, both on economic and engineering grounds.

TYPES OF INSULATING MATERIAL FOR DIFFERENT SERVICES—STATION WIRING

The majority of engineers who have had experience in central station construction now consider that cables without metallic sheaths are better than leaded or other metal-sheath cables for station wiring. The lead sheaths are generally grounded, and must be so in a high-tension system to prevent the accumulation of static charge. These grounded lead sheaths are an inducement for the arc from any conductor to earth in their neighborhood, to spread and cause trouble on adjoining cables. The lead sheath on circuits exceeding 5000 volts, and on all voltage if the cable is paper or fibrous insulation, must terminate in an end bell or pothead to prevent the breakdown of the cable at the terminus of the lead sheath. This end bell also serves as a seal to prevent the absorption of moisture in the case of paper or similar cable.

For tensions not exceeding 750 volts, cables that can be run in dry, non-metallic ducts without pockets, where water may collect, or on suitable incombustible insulators—porcelain, glass, slate shelves, concrete, etc.,—require insulation only to prevent shocks to operatives and short circuits due to mechanical causes, such as a workman dropping a wrench or bar across two bare conductors. An excellent type of cable for this work is one insulated with varnished cambric tapes and asbestos (asbestos being on the outside), finished with a flameproof braid. Such a cable can be operated continuously at the boiling point of water without injury. The varnished cambric, being inclosed in asbestos, does not induce any additional fire risk, as to weather-proof or rubber cables. The rate of deterioration is less than with other types, and the cost is low. The first use of this type on a large scale was in the Harrison street station of the Chicago Edison Company in 1893. Since then they have been largely used in station practice and have never given any trouble; they have in one or two cases come through fires practically uninjured.

For pressures of 1000 volts and upward we must use rubber cables of good quality, or some satisfactory substitute. Such cables, unless protected by individual fireproof runways, should have an asbestos jacket on the outside. This will prevent fire following along the cable, or bunch of cables; it also acts as a protection, to a considerable extent, from the destructive action of an arc from an adjoining conductor.

If rubber insulation is used it should be of good quality, and such cables cannot be cheaply made, owing to the present extremely high price of the better grades of crude material. Rubber cables should not be operated at temperatures exceeding 125 degrees F. if reasonably long life is expected of the insulation. Lower operating temperatures are most desirable, as they will do much to prolong the life of the insulating wall. Higher temperatures cause very rapid deterioration of the insulation. In Great Britain, and to a less extent on the Continent, various patented compounds, made usually from oils and bitumens, have been tried with fair success on low-tension work, and where they are not subjected to any high degree of heat. These cables are not adapted to the high temperatures that prevail during summer in most stations, nor will they give satisfaction when run at the high current densities common in the United States. The best that can be said of these insulations is they are more or less successful imitations of vulcanized rubber, and generally have all the faults of rubber insulation more or less exaggerated.

Many are no doubt familiar with the use of oil varnish films in the insulation of electrical apparatus, such as transformers, generators, motors, etc., usually used in combination with some woven fabric to give mechanical support to the film. The insulation consists briefly of cloth tapes especially treated and coated on both sides with multiple films of varnish. These tapes are applied to the cable, and between the tapes is a thin film of plastic insulating material which does not dry or become hard. The function of this plastic layer is to increase the flexibility of the cable by allowing the tapes to slide one upon another when the cable is bent. Cables thus insulated are tested and finished the same as rubber-insulated cables with braid, lead or any other desirable finish.

This type of insulation has all the good qualities of paper cables. It will withstand as high temperatures, is more flexible, has a considerably higher dielectric strength, and finally, most important of all, does not absorb moisture and can be used in interior work without a lead jacket. The varnish and cambric insulation, which we call V. C. for the sake of brevity, will not decentralize or deteriorate under temperatures destructive to rubber insulation. Mineral oil will not rot it. So far as data are obtainable, its rate of deterioration is less than that of vulcanized rubber of the best quality under like condition. Its dielectric strength is fully equal to that of rubber insulation. The method of manufacture is one insuring a homogeneous insulation of uniform dielectric strength—a point extremely difficult of attainment in rubber-insulated cables for high voltages.

This type of insulation is especially suitable for station wiring in the higher potentials and larger sizes of cables. It lacks only one quality to make it approach very closely the ideal—it is not in itself fireproof—but neither is rubber, nor paper. Like rubber-insulated conductors, it may be flame-proofed with asbestos on the outside, or, in fact, with any available material that can be used over the other insulations. It has not yet been applied to very small conductors for potentials below 1000 volts; for these, rubber is at present the best available insulation. For small conductors for high tension an inner wall of rubber and an outer wall of varnished cambric make an extremely effective cable, and one much cheaper than cable built entirely of rubber.

Conductors outside of the stations may be roughly divided into, first, transmission lines, practically always operated at potentials of 4000 volts or more and running to sub-stations, and, second, the distributing systems with feeders, seldom exceeding 3000 volts, and mains, to which customers are directly connected, operating at 500 volts or less. Circuits outside of the station using insulated cables are practically all underground. There are a few cases where high-tension leaded cables are run on pole lines supported by a steel cable similar to telephone practice, but this may be regarded as a temporary expedient.

Underground construction in the United States consists almost entirely of lead-jacketed cables in conduits, the most permanent type of duct being thoroughly vitrified tile. For installations where electrolysis can be guarded against or is not to be feared, paper-insulated lead cables give thoroughly satisfactory service when carefully installed. Where severe electrolysis is counted on or where the ducts are filled with water for considerable lengths of time, varnished cambric or rubber leaded cables should be used to ensure against interruptions of service. There are some successful installations of rubber cables, not lead-sheathed, in operation. It is, however, questionable if this is the best practice, since the ultimate life of the leaded cables will, the writer believes, be sufficiently extended to warrant the extra cost of the lead jacket.

Services to customers are installed in short lengths, although amounting to a considerable proportion of the cost of an underground system, and are most convenient when insulated with a material not requiring special sealing of the ends to protect against the absorption of moisture. It is a common practice to use rubber-insulated cables for this purpose, though the writer believes varnished cambric to be equally well suited to the requirements.

Where sub-aqueous lines are called for, various constructions are possible. With narrow, shallow streams or canals, the line of conduits may be dropped with deep manholes and the ducts carried underneath the bed of the stream. This usually necessitates draining the ducts toward one manhole and providing a small pump to keep the manhole clear of water seeping in. Wide, shallow streams can have a trench dredged or dug across them, and cables with band-steel armour laid in the trench, which will usually be rapidly filled with silt. For deeper or wider streams, armoured submarine cable is required. A method used with success in some cases is to lay a cast-iron water main with specially bolted ball and socket joints along the bottom of the river, and to draw an unarmoured leaded cable through it. Tunnels can, of course, be used, but except for a very heavy line containing a number of cables this construction is extremely expensive, and it is cheaper to instal one or more spare cables which can be switched into service in case of accident to one of the operating cables. It is perhaps well to mention here that where a submarine cable or underground cable is inserted in a pole line of any length, adequate lightning protection should exist at each end of the cable.

There is one type of cable largely used in Great Britain, and almost universally in Continental Europe, of which we do not avail ourselves as much as we should for underground work. This is the so-called band-iron armoured cable. Leaded cable is wrapped with tarred jute over this, with two overlapping steel tapes, each from one-thirty-second to one-sixteenth inch thick. The outer tape covers the butt joint in the inner tape, and is protected against corrosion on the outside by an additional jacket of compounded jute. Such cables buried directly in the earth have been giving first-class service in some cases for twenty years. They are in use for pressures from 250 up to 15,000 volts, and lines of even higher potentials have been installed, but for too short a time to be cited.

There are many cross streets where a distributing main of only, say, three No. 0000 conductors, is required. A single duct with small manholes every 75 feet for service distribution will cost at least 50 cents per duct foot, including service manholes and omitting all paving charges. Single No. 0000 cables suitable for this use can be armoured for approximately 8 cents per foot, or 24 cents for three cables, showing a direct saving of 16 cents per foot of three-wire main, allowing 10 cents for trenching. If smaller sizes of conductor were used in the comparison, the saving of the armoured cable over the duct would be largely increased, since the duct charge is fixed, while the cost of armouring is approximately proportional to the size of the cable. With such constructions, services can be installed at any point, the joint being protected by cast-iron T-boxes.

Such cables are usually installed inside of the curb, saving the expense of disturbing expensive pavement. Cables thus installed can run into manholes belonging to the conduit system at either end of the block and be then worked in with the regular distributing system. For service to buildings set back from the street, for an underground system connecting a group of buildings of a permanent character, such as a college with fine grounds, where overhead lines are an eyesore, and for complete systems in small cities where the conduit system is too expensive, this type of cable represents a neglected opportunity to American engineers.

PROPER REQUIREMENTS AS TO TEST PRESSURES

Before it is shipped from the maker's factory, every cable should be tested with a potential higher than the maximum working pressure. If possible, a similar test should be made after the cable is installed and jointed. As to the relation which these test pressures should bear to the working pressure, the duration of the tests, etc., there exists considerable diversity of opinion. For a good many years the writer has advocated two and one-half times the working pressure for thirty minutes to an hour as a factory test, and twice the working pressure for the same length of time after the cable is installed. Cables tested under these requirements have given no indication in practice that the margin of safety was not ample.

Some engineers, desiring a higher factor of safety on important and large installations, specify a factory test of three times the working pressure and a test installed of two and one-half times. Any requirement more severe than this represents a questionable investment on the part of the purchaser. It is especially undesirable to make very high potential tests for very short periods of time, since the cable may be decidedly weakened by such treatment, although it does withstand the high-potential test for the brief period specified. In short, in the writer's opinion, the words "breakdown test" should not appear in cable specifications. Boilers are tested to see if they are safe for a given working pressure, but such test is not usually referred to as a bursting test. Cable tests should be considered on the same basis. They are not to show the ultimate strength of the cable, but to show that the cable is safe and satisfactory for the purpose for which it is intended.

It should, of course, be understood that the above refers to cables for 2000-volt circuits or over, since in lower voltages the necessary mechanical requirements frequently call for a wall of insulation sufficient for a 3000-volt test or even a 5000-volt test on cables which are to operate at 250 volts. A very good variation in tests called for by some engineers is to test the cable for one hour at two and one-

half times the working pressure, and at the end of that period to raise the pressure to three times the working pressure for one minute.

Paper cables are not generally tested at more than 2300 volts for each 1-32 inch of wall, rubber cables at 2500 volts for each 1-32 inch of wall; varnished cambric cables we are enabled to test with 2800 volts for each 1-32 inch of wall. These figures apply, of course, to the ordinary commercial cables as made to-day. They can be exceeded on specially made cables of all types. The size of the cable has a considerable bearing on the pressure test, and the figures above represent the practice on cables running from No. 6 and larger, for working pressures from 2000 to 20,000 volts.

In concluding this paper the writer strongly advises any central station man who contemplates underground construction to procure a copy of the paper on underground construction, read by L. A. Ferguson, in 1904, at the Electrical Congress at St. Louis. It contains a mine of valuable information, which, so far as the writer knows, has nowhere else been published.

Electric Iron Smelting in Canada

THE smelting of iron ore by electricity is to have a practical working test in Canada. The Dominion government, according to "The Engineering and Mining Journal," has appropriated $15,000 for the purposes of the test, and a building and free power will be furnished for a limited period at the Sault Ste. Marie works. The test will be under the special charge of M. Héroult, the French engineer, who has a wide reputation for his operations and experiments in electrical smelting in France. It is understood also that some experiments will be made with nickel ores from Sudbury. Should the experiments result successfully, the Canadian government will probably spend a larger sum in erecting a plant at some point in the vicinity of the iron ranges of western Ontario.

An electrical trades exhibition will be held in Madison Square Garden, at New York City, from December 12 to 23 this year. It is to be devoted to the developments of electric engineering generally. George F. Sever, 26 Cortlandt Street, New York, is director of exhibits. The show will be under the management of the Exposition Company of America.

Standard in Preference to Special Machinery

By DAVID HALL, of the Bullock Electric Mfg. Co.

A Paper Read at the Recent Denver Meeting of the National Electric Light Association

THE purpose of this paper is to call attention to the important advantages, to both purchaser and manufacturer, in the use of standard, in preference to special, machinery. This is not a case in which the manufacturer alone is benefited; the points of advantage are mutual. The purchaser in selecting standard machinery aids the manufacturer in producing a more efficient and a more perfect machine at a lower cost.

The most successful power plants must be characterized by reliability and economy of operation. There must be machinery sufficient to meet all emergencies, and the machinery should be of as simple construction as possible, as simplicity is the key to reliability and complications cause troubles. The experimental stages of machinery of all kinds are examples of how complicated apparatus can be made, while its ultimate success depends upon the eradication and simplification of the parts so that the machine as a whole is easily understood and easily operated. With the advent of a new machine, we say "how complicated"; when the same machine is perfected, we say "how simple." It is therefore to the advantage of the purchaser that machinery become standardized.

If only one machine is built from each design, and we have an infinite number of designs, the result is an infinite number of experiments, and it is only after one of these machines is thoroughly tried and perfected that we have a machine which can be called standard. However, if we assume that no two machines that are purchased are to be alike, there would be no incentive for standardization.

This paper refers to "standard machinery" as machinery that is regularly listed for sale by a reputable company, such machinery having been built and standardized. The first machine of almost any description is capable of being improved upon. Sometimes the improvements suggest themselves after a very short test, while other improvements may be made only after a long period of operation. In fact, it may be said that the longer a machine of a given type is operated, the more certainly can the good points be determined and the more pronounced are the bad features that are to be overcome. Consequently, it is positive that the purchaser has everything to gain, in so far as operation is concerned, by selecting machinery that is standard and does not possess experimental features.

It is to the interest of the purchaser and operator of every machine to know that spare parts can be readily obtained, for in the operation of machinery in general there are certain to be requirements for new parts, made necessary on account of wear or accident, and it is usual that such parts are wanted on short notice. If the machine is standard, such parts are likely to be found in stock, or, at any rate, can be furnished quickly. On the other hand, if the machine is of special construction in part or throughout, there is great probability of delay, and such delay may be very expensive as well as annoying. In fact, a long delay may cost more than the machine is worth.

In the natural course of events in the operation of mills, factories and power plants, changes of help are continually taking place, and there is no machine so simple that the experienced operator can not produce better results with it than can the inexperienced. It is, therefore, of importance that machinery be of such a nature that it can be easily operated, and this point must not be overlooked in making machinery standard. The more machines there are in operation of a given kind, the more men there must be who are familiar with operating them and, consequently, the easier it must be to obtain an experienced operator.

Delivery of machinery is usually second in importance only to price, and it is not a rare occurrence that delivery is even more important than price. That standard machinery can be delivered more quickly than special machinery needs no proof. At the same time it is not always so plain to the purchaser why a special request as to speed, exact output, or detail of construction of a machine may delay its delivery three months, whereas a standard machine, differing only slightly from the specifications, might have been delivered immediately. At the same time the standard machine might meet the requirements and do the work as well as, or better than, the special machine. Change of designs, change of drawings, new patterns, new tools and new castings are matters that are given little thought or consideration by the purchaser, yet these are the things that keep the non-produc-

tive element of a shop busy, make prompt deliveries impossible, and keep the management searching for profit when there is only loss. Do not overlook the fact that these numerous expenses, due to changes of design, must be paid for, either by the purchaser or the manufacturer, and it is often the case that only a part of these extra expenses are paid for by the purchaser, and the rest is made up by a sacrifice of the profit by the manufacturer.

A certain manufacturing company has made 100-K.W. direct-current generators at the following speeds:—100, 125, 150, 225, 240, 250, 260, 275, 580, 650, 750, 900. To-morrow they may be asked to make a machine of still another speed. Why? Because the purchaser's specification is drawn so fine as not to permit of a standard machine. It is true that they may be so drawn as to fit one manufacturer's standard machines, but every other manufacturer, in order to meet the specification, must bid on a machine that is special to him. The purchaser therefore receives one bid on a standard machine and five bids on special machines. Does such a specification give the purchaser the benefit of standardization?

Assume that the specification is drawn for a belted machine running at 800 revolutions per minute. Would not 750 or 825 meet the requirements? Had the specification been so drawn that each manufacturer could submit a bid on his standard machine, together with guarantees and full information regarding detail construction, then the purchaser or his technical adviser would have an opportunity of acting as a judge in the matter of selecting the particular standard machine that was best suited to his requirements—rating, price, guarantees, and details of construction all being considered. In other words, the purchaser should act as judge and not as designer.

Another point to which attention is directed is the value of the investment. Expansion of business often necessitates larger machinery, and it often becomes necessary to dispose of the machinery on hand. The price that can be obtained will now depend upon how well the machinery is suited to the demands of some other purchaser. If you have a motor with a special shaft, a special end head, or a special foot, a sale at any price is difficult to make. At the same time there is always a market for standard machinery.

The price of machinery is usually a base of comparison in purchasing, but operation is the test of quality. Poor operation is dear at any price; it is therefore of interest to the purchaser to determine how he can best obtain full value for the money invested. This he can certainly not get by asking for that which is special or out of the regular line. The development charges on all new machinery constitute a large item, and it is only by standardizing that development charges can be distributed.

The purchaser should realize that in selecting standard machinery he will not be burdened with development charges, and he will have the advantage of all the refinements of manufacture whereby standard apparatus, in virtue of being made in quantity, is made both better and cheaper than it could otherwise be. It is, therefore, plain that the purchaser should make known his requirements to the manufacturer by stating fully the conditions to be met and the work to be done, by so shaping his requests that the manufacturer can offer to him apparatus that is standard and that has been "tried out" in all its details. Each specific condition that the purchaser inserts in a specification reduces the probability of standard apparatus meeting the requirements. In other words, the purchaser, in making inquiries for machinery, should state all necessary requirements, but should carefully avoid the addition of unnecessary requests. If the specifications are so drawn, the manufacturer can offer the purchaser standard machinery with guarantees, and the price of the machinery may be considerably lower than if the purchaser had filled his specifications with a number of unnecessary conditions.

Many specifications would be more to the advantage of both purchaser and manufacturer if they were cut short at the end of one page instead of being drawn out to the extent of twenty pages. Let the purchaser define the work to be done, and let the manufacturer prescribe the machine to do it. If the purchaser wants his machine made to order he may be sure it will be too small in the waist or too long in the leg to suit his neighbor, and that he will have to settle a tailor's bill in addition to a manufacturer's cost.

Telephone Life-Saving Service

A PATROL system of telephones is to be installed in the Fifth Life-Saving District, extending along the New Jersey coast from Cape May to Sandy Hook. A metal box, fitted up with a set of telephones, will be placed at each halfway place where the patrols meet. This will enable the keeper of the station to communicate with the patrol, and the patrols can call their attention in case of wreck or accident. Under the present arrangements, if a patrol saw a vessel in distress, he would have to run back to his station to report the matter, in doing which he would lose valuable time.

Hydro-Electric Power in Peru

WRITING under recent date from Callao, Peru, of the water powers available in Peru for electrical development, United States Consul A. L. M. Gottschalk gives the following information furnished him by C. Reginald Enock, an English engineer:—

Peru possesses a valuable element in the yet undeveloped hydraulic power which exists on both the eastern and western slope of the Cordillera of the Andes. The source of this water supply is the ice cap above the line of perpetual snow which crowns the summit of the range and the continual and exceedingly heavy snow and rain storms of the high plateaus. All along this vast chain, from Ecuador to Chile, there exists a series of lakes, practically astride the summit of the Andes, at altitudes varying from 12,000 to 17,000 feet above sea level, and these, together with the streams to which they give rise, form the source of enormous hydraulic energy. The volumes of water which descend upon the Pacific side are not necessarily very great, but they are numerous and constant and their fall is exceedingly rapid.

As an example, the river Rimac, which rises in the ice cap of the Cordillera, at an elevation of more than 17,000 feet, debouches on the coast at Callao, with a course not more than 80 miles long. This river is already used as motive power for generating electricity for the railway between Lima and Callao, and could furnish constant and unlimited power over any portion of its course. Similar conditions exist, more or less, with the numerous other rivers and streams all along the 1500 miles of Pacific littoral belonging to Peru.

On the eastern slope of the Cordillera the volume of the streams is greater, for the rainfall is far heavier, due to the well-known climatic conditions to which the Andes give rise. In short, the Andes may be considered as a mighty engine, continually intercepting and storing up the moisture of the continent upon its summits, and thence discharging it again under such conditions as create energy in a limitless form and available for the use of man.

Artificial Illumination—II

By Dr. EDWIN JAMES HOUSTON

Continued from the June number

INDIRECT ILLUMINATION

ARTIFICIAL illumination can be conveniently divided into two general classes,—direct illumination and indirect illumination. In direct illumination the source of light is so placed that its rays fall directly on the area to be illumined, little or practically none of the light reaching such areas by diffusion. Consequently, the source of light is left practically bare or uncovered by any opaque or semi-opaque substance. Sometimes a portion of the luminous source is covered with a hood or so-called reflector so as to prevent the passage of any portion of the light upwards. As a rule. however, most of the source of illumination is left bare or uncovered, so that its light is thrown directly on the space to be illumined as well as the surrounding space.

Direct illumination is employed for the lighting of such large areas as streets, grounds, squares and public works generally, where uniformity of illumination is a matter of comparatively small importance. Direct illumination is unfortunately too frequently employed for the lighting of the inside of buildings, such as workshops, public halls, stores and shop windows, as well as for general artificial illumination, and will be discussed in a subsequent article on direct illumination. Even in the cases of the large areas referred to, indirect lighting might be advantageously employed.

In indirect illumination, the luminous source is so placed that the light-rays are not thrown directly on the objects or area to be illumined, but on surfaces that are placed near the source, the rays being thrown from these secondary luminous surfaces either by regular reflection or by diffusion.

In all cases of indirect illumination the best results are to be gained by the use of irregular reflection or diffusion instead of regular reflection,—that is, the luminous source throws its rays on surfaces that are covered with specially prepared substances, such, for example, as aluminium paint, that possesses in a marked degree the power of diffusing or scattering light. While in indirect illumination the objects or areas to be illumined receive their light from reflecting or diffusing surfaces in this manner, yet, in many cases, a small portion of the light is also received by radiation or diffusion from suronnding objects.

It will be seen, therefore, that direct illumination differs from indirect illumination mainly in the fact that in the former the light falls directly on the area or objects to be illuminated as it is radiated from the luminous source, while in the latter the luminous source is employed to produce a series of additional luminous sources that throw their light on the objects by a secondary or tertiary difdiffusion. The secondary diffusion takes place from the specially prepared surfaces that are placed near the luminous source, while a tertiary diffusion comes from the walls and ceilings of the room or objects placed near the bodies that are being examined.

In indirect illumination, surrounding objects receive practically all their light by means of diffusion, little or none of the light being received by direct radiation from the source. It is difficult, however, to draw sharply marked lines that shall distinguish direct from indirect illumination in this regard, since in many cases of indirect illumination some of the light is permitted to fall directly on the objects to be illumined. In no case, however, does such light bear a large proportion to the diffused light received by such objects.

It is especially characteristic of indirect illumination that the luminous source is placed in a position where its direct rays fall on specially prepared surfaces, from which it is thrown on to surrounding objects either by reflection or by diffusion. As has already been pointed out, the best type of artificial illumination is obtained where diffusion and not reflection is employed for such purpose.

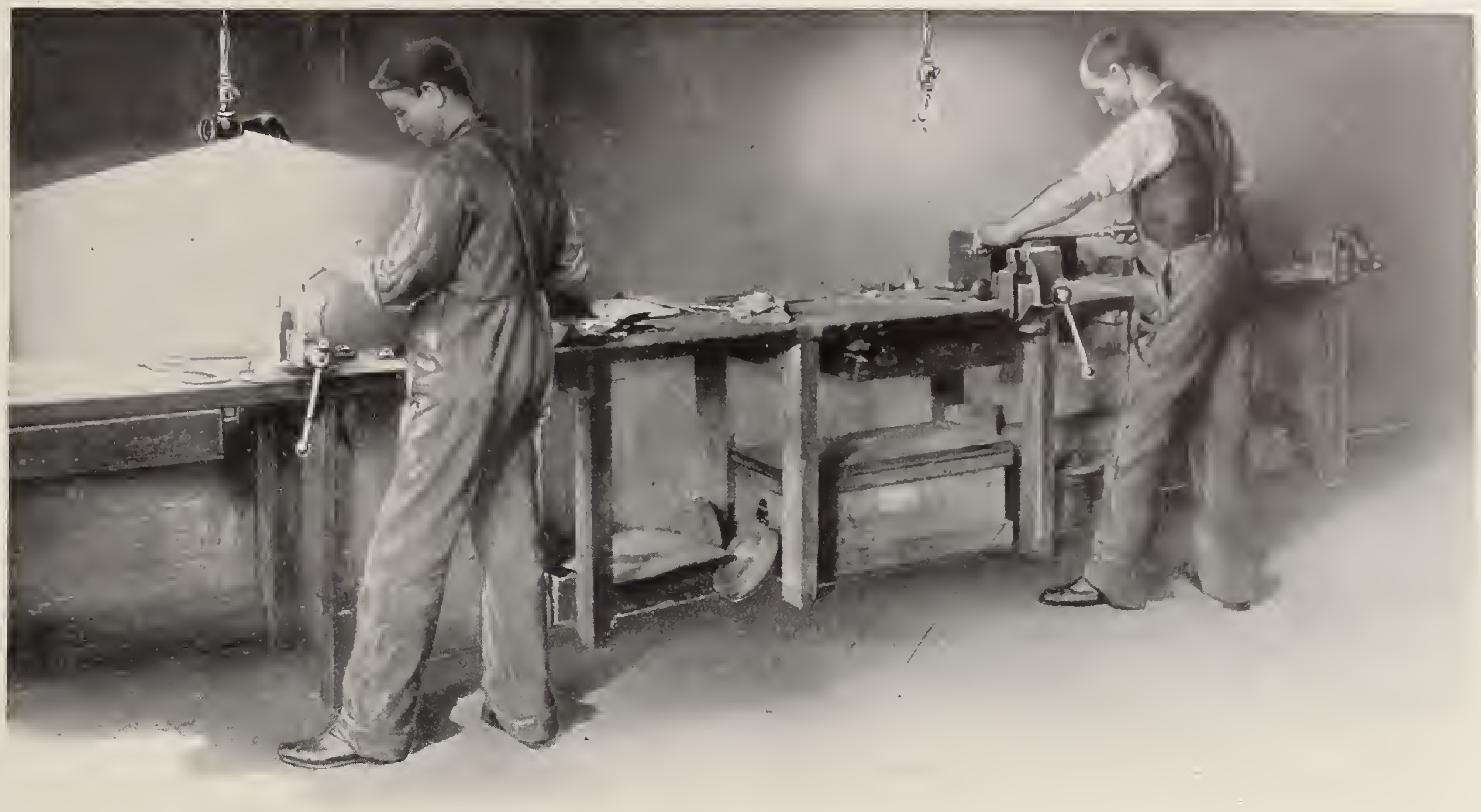
At the present time, by far the greater proportion of artificial illumination is effected by means of direct illumination. Indirect illumination, however, possesses such marked advantages over direct illumination that the time is probably not far distant when the former will be employed for most cases of interior illumination. Since the disadvantages of direct illumination can best be understood from a careful study of the peculiarities of indirect illumination, we will first discuss the newer method.

Concisely stated, the employment of indirect illumination ensures the following advantages:—

1. Surface illumination in place of point illumination.
2. Uniformity in the intensity of the illumination.
3. Greater freedom from the regular reflection of light from the illumined objects.
4. A protection of the eye from the direct rays of the luminous source.

In indirect illumination, the illumined areas receive practically all their light by means of diffusion, this being obtained mainly from more or less extended surfaces that are especially placed and prepared. These surfaces are placed so as to receive the greater proportion of the light emitted from the luminous source, and are especially prepared by being covered with some substance, such as aluminium bronze or aluminium paint, that possesses a high power of diffusion. Under these circumstances the illumined areas receive their light from what practically constitutes a great number of single secondary light sources, from each of which divergent rays or pencils of light are thrown in all directions, except that in which they are prevented from passing by the opacity of the shade or reflector. It is evident that under these conditions there will be ensured all the advantages that are derived from a surface illumination as distinguished from a point illumination, since the extent of the surfaces from which the diffused light is thrown is always such as to ensure the existence of a very great number of secondary luminous sources.

The characteristic uniformity ensured by means of indirect illumination gives this method marked superiority over direct illumination. It is practically impossible for the latter to successfully compete with the former in this respect. Take, for example, the case of a bare uncovered arc



An Eight-Candle-Power Lamp, with D'Olier Universal Socket and Shade. A Sixteen-Candle-Power Lamp, Used in the Ordinary Way.

FIG. 5.—AN ILLUSTRATIVE CASE OF THE COMPARATIVE RESULTS OBTAINED FROM SHADED AND UNSHADED LAMPS

light. Here the luminous source can be practically regarded as a single point. Not only does the light rapidly decrease with the distance from the source, but the illumination is necessarily characterized by sharp shadows cast by the illumined objects.

It is true that such shadows can be decreased by increasing the number of luminous sources,—that is, by employing a number of bare arc lights and placing them at different positions over the area that is to be illumined; but it is commercially impossible to carry this increase to such an extent for the illumination of limited areas as to be able to obtain as uniform an illumination as is possible by means of diffusion, since under such circumstances the number of separate secondary sources becomes exceedingly great.

Suppose, for example, that instead of using a single bare arc light, the lamp be so placed under a shade covered wih some good diffusing substance that besides the direct light falling on the space below, the space shall be lighted by the indirect illumination ensured by diffusion from the shade. Under such circumstances a much closer approach to uniformity of illumination will be obtained in that part of the area immediately under the single arc light than would be the case were the light employed bare and without the diffusing shade.

In order to increase the uniformity of the area of illumination under the above circumstances, it is common practice to surround the arc light with a globe of ground glass or translucent porcelain, which shall have the effect of scattering or diffusing the light. Under these circumstances, however, the uniformity in the illumination would not be as marked as it would be if all the light that is permitted to fall on the illumined space were derived from the diffusion from the secondary sources obtained from the area covered with the diffusing material.

Another advantage which indirect illumination possesses over direct illumination is to be found in the marked decrease in the amount of light that can be regularly reflected from the surfaces of the illumined bodies. Where a single strong luminous source is employed, as, for example, a bare arc light, or, even with a number of incandescent electric lamps, a difficulty will sometimes be met by too great a proportion of the light being regularly reflected from the surfaces of the illumined objects to the eye of the observer.

As already pointed out, regularly reflected light is not only useless for

FIGS. 6 AND 7.—TWO DIFFERENT FORMS OF SHADES MADE BY THE HENRY D'OLIER, JR., COMPANY, OF PHILADELPHIA, IN ONE OF WHICH THE INCLINATION OF THE OPPOSITE SIDES IS UNEQUAL, AND IN THE OTHER EQUAL AND PARABOLIC IN SHAPE

the purpose of ensuring distinct vision, but actually prevents it. Now it will be evident that where a bare arc light is employed, the liability of directions existing in which a maximum amount of light will be regularly reflected from the illumined objects will be much greater than if a very great number of secondary sources of illumination be employed, as in the diffusion method, since from every one of such luminous points diverging pencils of light fall in all directions on the object.

But the principal advantage of indirect over direct illumination lies in the fact that with the former the light from a luminous source can be absolutely prevented from directly entering the eye of the workman, the light which so enters the eye being limited to the diffused light from all parts of the illumined obect. This is important because it is only by preventing the entrance of such light that the best vision can be secured.

It will be noticed that the advantages of indirect illumination above enumerated are practically the same as the advantages possessed by ordinary sunlight as an illuminant, since indirect illumination possesses characteristics that closely resemble those already pointed out as possessed by ordinary daylight illumination,—for example, uniformity of illumination, the prevention of disagreeable shadows, the prevention of regular reflection from the objects illumined, and the thorough protection of the eye of the observer from the entrance of direct light from the luminous source.

One of the first practical applications of indirect lighting on a large scale was that employed at the Paris Exposition of 1881.

An excellent practical system of indirect illumination is obtained by the use of the "Universal" socket and shade made by the Henry D'Olier, Jr., Company, of Philadelphia. This system of artificial illumination is based on the principle of diffusing the light of the luminous source as opposed to regularly reflecting such light. In the D'Olier socket and shade an incandescent electric lamp of any suitable candle-power is placed within a cover or shade that is covered with metallic aluminium paint so placed on its inside surface as to retain its power of diffusing light to a marked degree. The characteristic white color of aluminium ensures the presence of a certain proportion of white rays, the amount of which will vary with the character of the lamp employed.

FIG. 8.—VARIOUS FORMS OF THE D'OLIER SHADE USED IN THROWING THE LIGHT IN DIFFERENT DIRECTIONS

The peculiarity of the D'Olier socket and shade is that its construction is such as to permit both socket and shade to be rotated around two independent axes situated at right-angles to each other. Thus not only can the shade be placed in any position by moving it around its vertical axis, but it can also be itself inclined so as to throw the light on the ceiling, on the floor, or in any intermediate direction between these two positions by rotation around the horizontal axis. In this manner it is possible to readily throw the greater proportion of the light to any particular part of a room or work that may require to be illumined.

Figs. 6 and 7 show two different forms of shades. In Fig. 6 the flare or inclination of the two opposite sides is uneven, and the plane of the opening of the shade is not horizontal, but inclined. In Fig. 7 a conical or parabolic shade is employed, provided of course with equal flares, the plane of the opening of the shade being capable of adjustment in a horizontal position.

By the use of these two different forms of shades, a uniformly illumined area can be obtained below the lamp. In the case of the form of shade shown in Fig. 6, the area illumined will lie generally to the left of a vertical line passing through the center of the shade. This distribution of the light arises from the fact that the more nearly vertical flare of the right-hand side of the shade permits a greater portion of the light to be radiated to the left than that radiated from the left-hand portion of the shade.

In Fig. 7, the flare being equal on both sides when the shade is in the position shown,—i. e., with the plane of cross-section of the opening horizontal,—the area of uniform illumination would be evenly distributed around a vertical line passing through the focus of the parabola, or the central part of the conical shade where a conical form of shade is employed. By means of the axes of rotation in this socket and shade, the position of the area of illumination can be readily shifted.

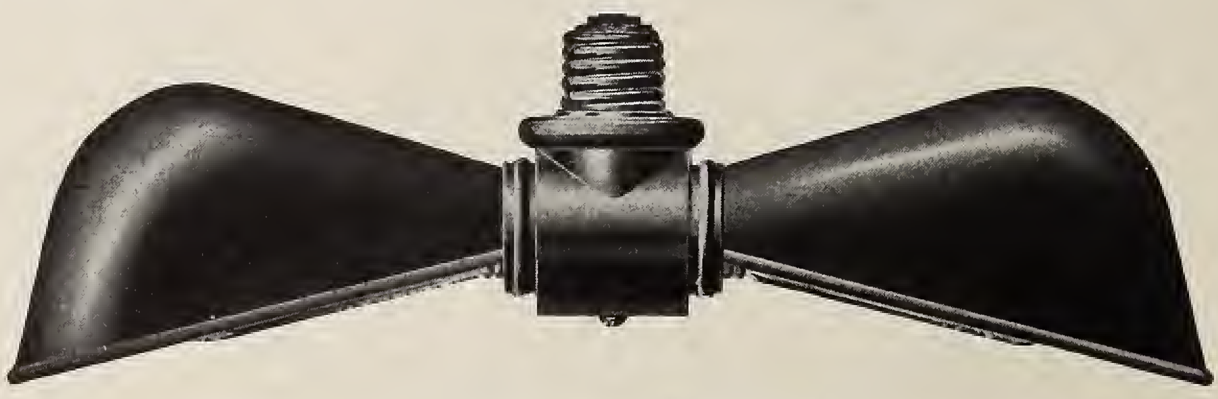


FIG. 9.—A COMBINATION OF TWO D'OLIER SHADES, ELIMINATING THE USE OF A COUNTER-WEIGHT

Where the D'Olier socket and shade are supported, as is frequently the case, by a suspension wire which carries the current into the lamp, they are balanced in a horizontal position by a counter-weight. By the use of this device the workman is readily

able to adjust the shade so as to throw the diffused light in any direction that may be required, while, at the same time, he can easily prevent the direct light from entering his eyes, and thus ensure the best view of the details of the work. This is a matter of considerable importance in a machine shop, where work is being done on a planer, lathe, or other machine tool. It is also important in the case of a shade placed over a reading or drawing table, since it permits the light to be thrown directly on the book, paper, or other work.

FIG. 10.—A DOME-SHAPED CLUSTER FOR USE IN THE CEILING OF A ROOM, SHOWING SEPARATELY THE SHADED LAMPS AND THE SURROUNDING RECEPTACLE

Where such a light is placed in a room, the light may either be thrown directly on a book, for the convenience of a reader sitting at a desk, or, when so desired, it may be readily directed to a different portion of the room for the convenience of a distant reader.

A little thought will show the great advantages that are ensured by the employment of a shade of this character over an ordinary bare unhooded electric lamp. Take, for example, the ordinary bare 16-candle-power incandescent electric lamp that is represented as hanging from a pendant wire at the right in Fig. 5, and compare it with an 8-candle-power electric lamp placed in a D'Olier socket and shade, as represented at the left in the same illustration. The bare unshaded lamp radiates its light in all directions, practically as much passing to the ceiling and portions of the room above the work as that which falls on the work itself. At the same time, a certain proportion of the light enters the eyes of the workman, resulting in an unnecessarily rapid loss of sensibility of portions of the retina of the eye, and, consequently, in inability to properly distinguish the details of the work. In other words, a large proportion of the light is permitted to fall where it is of no use to the workman; a smaller proportion only falls directly on the work, while by no means an inconsiderable portion is thrown directly in the face of the workman, where it causes positive injury.

By the use of a D'Olier socket and shade provided with its diffusing surface of aluminium, all loss of light above the surface to be illumined is prevented, and the light is uniformly concentrated on the work, thus producing an illumination that necessarily possesses a greater intensity than would otherwise be possible,—for example, in the case of the 8-candle-power light represented on the left in Fig. 5, a far greater intensity of illumination is produced on the work than is received in the case of the 16-candle-power light represented at the right in the same figure. It has been shown by actual measurement that a 16-candle-power lamp when placed within a D'Olier shade is capable of producing an illumination of 59.4 candle-power on work placed as represented in the figure. This is, of course, due to the concentration of the light on the work.

Fig. 8 gives some idea of the different directions which the light can be made to take by the use of different forms of the D'Olier shade. By placing two shades in the positions shown in Fig. 9, the use of the counter-weight may be done away with, since the weight of one shade can be employed to balance the other. This form of shade is known as the double socket and shade. It is suitable for the illumination of larger areas without the necessity for placing the light at too great a distance above the work.

Fig. 11 shows an adjustable portable shade, which is capable of being readily placed so as to illumine a book on a table, or in the case of a desk where the space for a lamp is lacking, the lamp can be instantly changed from a vertical to a horizontal position. Where the light is to be placed in the ceiling of a room, the dome-shaped cluster body shown in Fig. 10 may be employed. Here, as shown at the left in figure, three separate incandescent lamps and shades are placed inside the receptacle.

Every point at which it is necessary to tap a high-tension transmission line and take power becomes a point of danger, a point where accidents may happen; and the higher the high-tension voltage, according to Paul M. Lincoln, the more difficult and expensive it becomes to take power from the line, and the greater becomes the liability of danger. This point becomes a good reason for reducing the number of transformer stations to a minimum. There is no golden rule for the determination of the spacing and capacity of transformer stations or the size of the conductor. It is a matter of compromise between various elements, some of which point in one direction and some in the other, and a matter which must be determined by engineering judgment rather than by any inflexible law.

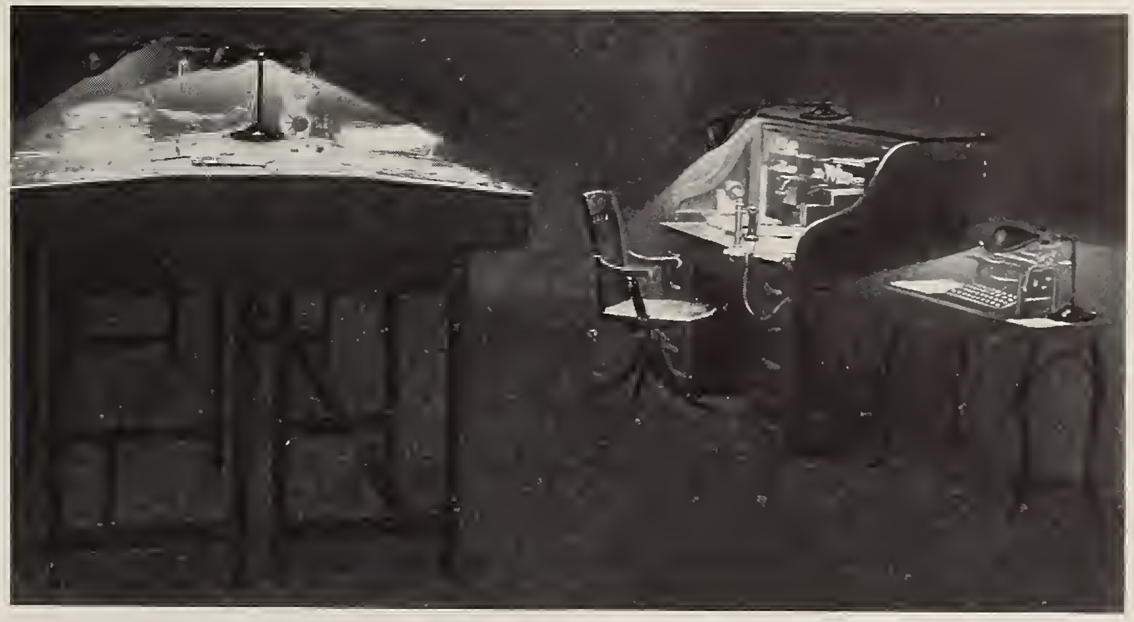


FIG. 11.—SOME OF THE APPLICATIONS OF AN ADJUSTABLE D'OLIER PORTABLE SHADE

Series Alternating-Current Motors for Industrial Work

By CLARENCE RENSHAW, of the Westinghouse Electric & Manufacturing Company

A Paper Read at the Convention of the National Electric Light Association, Held at Denver, June 6-11.

THE commercial production of the series alternating-current motor, which marks such an advanced step in the development of suburban and interurban railways, is also an important event from the standpoint of central-station managers. The importance of obtaining day loads so that plants may be kept running on a profitable basis at all times instead of for merely a few hours a day is well recognized, as is also the fact that the ideal system for central-station work is one that permits the operation of all classes of lighting and power service from the same machines and circuits. Except for supplying the most densely populated sections of the larger cities, the polyphase alternating-current system is now the recognized standard for lighting, and, by the use of induction motors, power for a majority of purposes may also be supplied. There are certain classes of work, however, for which induction motors are not entirely suitable, and the lack of a satisfactory alternating-current motor for the work to which direct-current series motors are ordinarily applied has hindered to some extent the use of alternating current in industrial establishments.

The use of alternating-current motors for the operation of mills, factories and the like, offers an excellent chance to central stations to dispose of their surplus daylight power, so that the development of the series motor, extending the classes of work that can be done by alternating current, and thus bringing the system one step nearer to the ideal, is of vital interest and importance.

Polyphase and single-phase induction motors have many excellent characteristics and are well adapted for purposes requiring a constant-speed motor, but it cannot be denied that for the operation of cranes, hoists and similar machinery used for intermittent service, they are not as satisfactory as series motors.

In most industrial establishments work of this character forms but a small part of the total service for which electric motors are required, although it is sometimes of sufficient importance to necessitate the choice of direct-current apparatus instead of alternating. In order to permit such establishments to be operated entirely by means of alternating current, special types of induction motors have been designed which can in general perform these classes of service better than the ordinary constant-speed induction motors, although not as satisfactorily as the direct-current series motor.

The polyphase induction motor is similar in its characteristics to the direct-current shunt motor, and when this fact is recognized the reasons for the above statement will be evident. Variable-speed machinery, such as is ordinarily operated by direct-current series motors, usually requires a large starting torque, and it is also desired, in general, that the speed of such machinery should vary inversely as the load. The characteristics of the direct-current series motor are such that the torque increases much more rapidly than the current, so that with double full-load current, from two and one-half to three times full-load torque would ordinarily be developed, and also that the speed varies widely with the load. In the case of the direct-current shunt motor, however, or the induction motor, the speed is nearly constant regardless of the load, and the torque is nearly proportional to the current, so that in order to obtain three times full-load torque practically three times full-load current would be required.

The series alternating-current motor, however, has in general the same characteristics as the direct-current series motor, and a line of small motors of this type for both 25 and 60-cycle circuits has now been developed

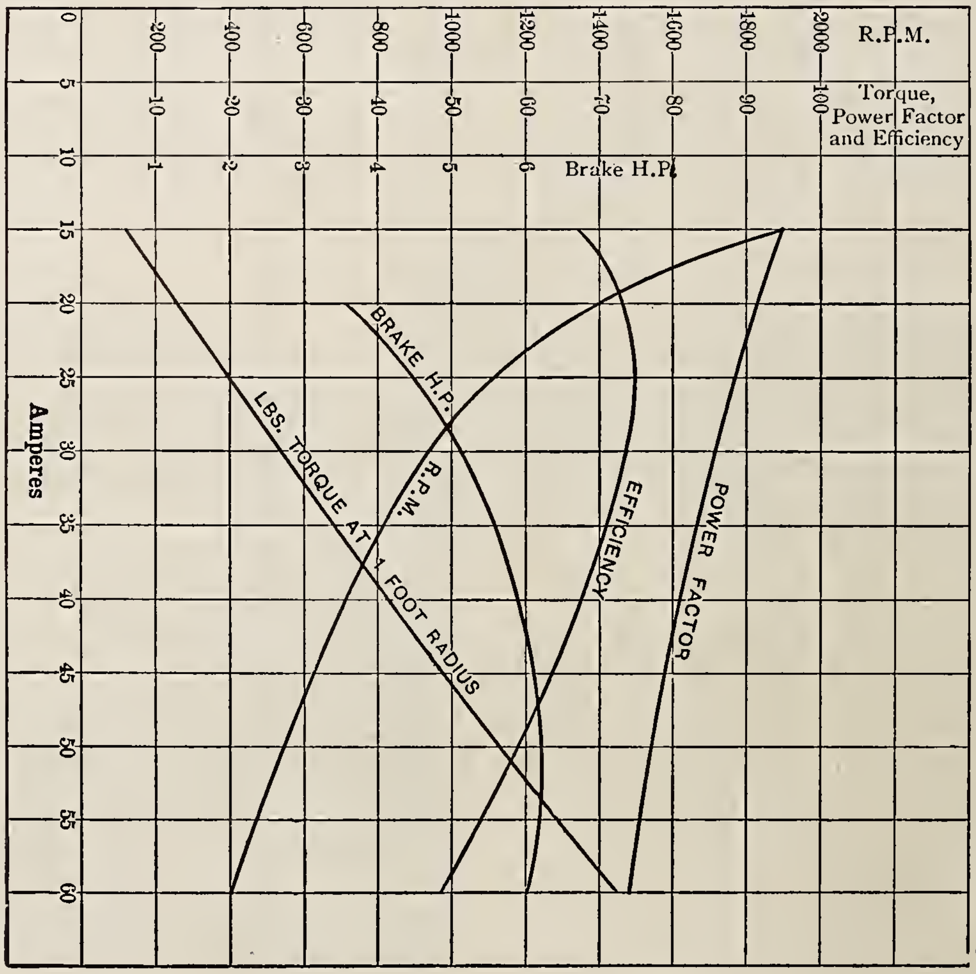


FIG. I.—PERFORMANCE CURVES OF NO. I, 25-CYCLE, TYPE SC MOTOR.

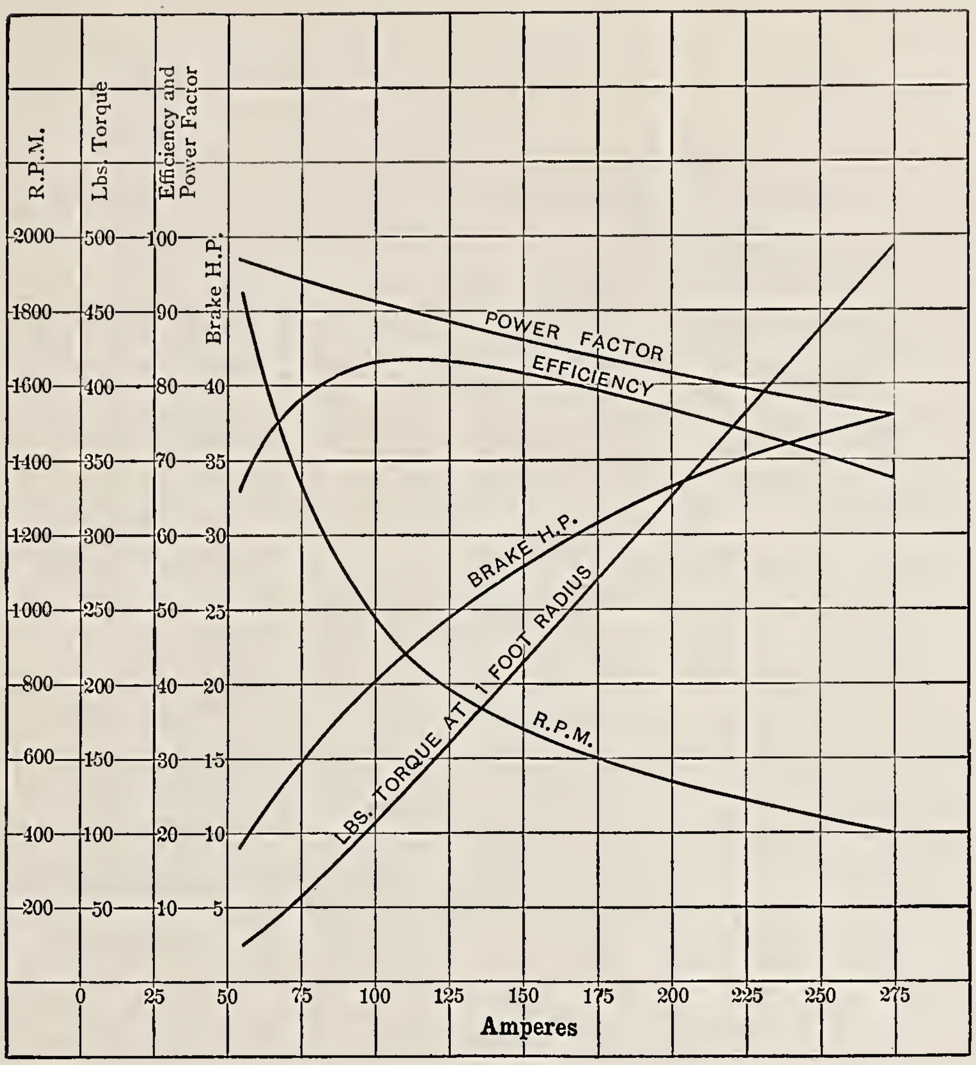


FIG. 2.—PERFORMANCE CURVES OF NO. 4, 25-CYCLE, TYPE SC MOTOR

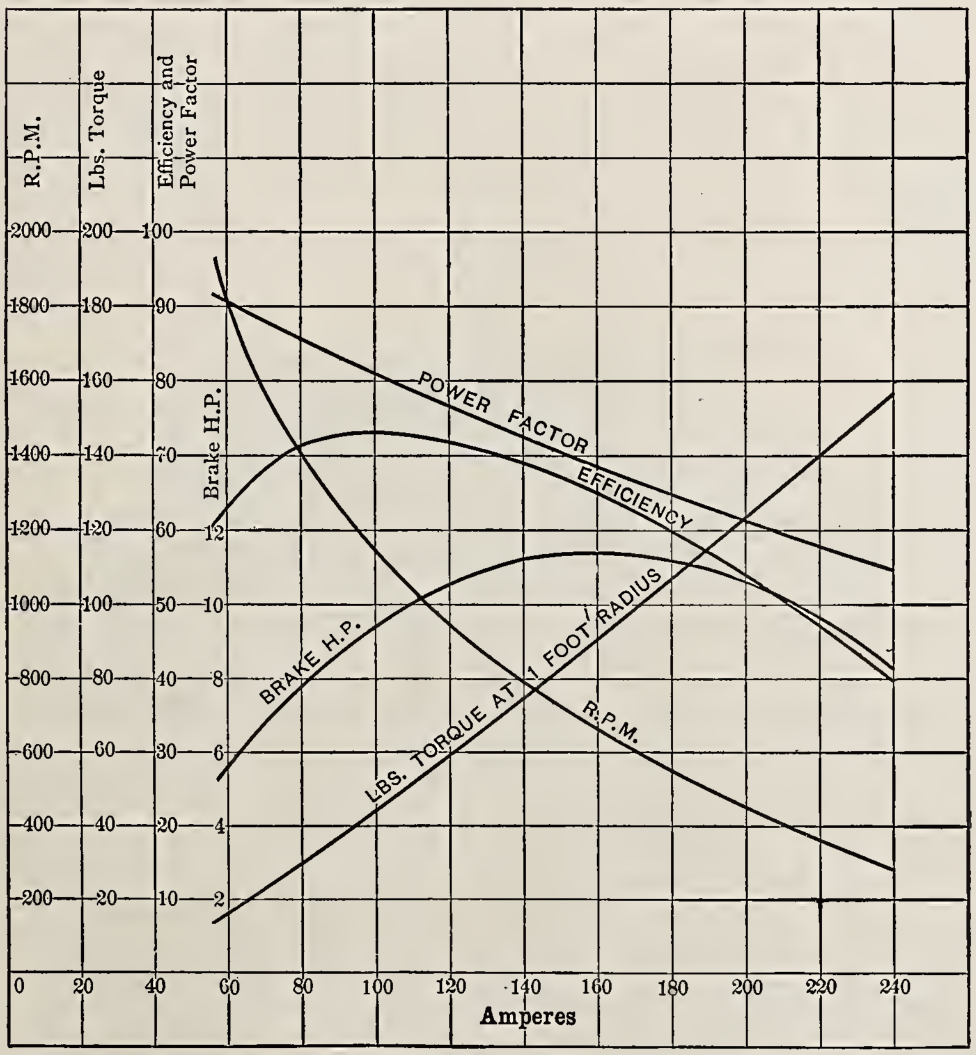


FIG. 3.—PERFORMANCE CURVES OF NO. 2, 60-CYCLE, TYPE SC MOTOR

and placed on the market for industrial service.

This type of motor is designated as "SC," the letters indicating "Single-Phase Commutator." By its use cranes, hoists, and similar machinery can now be operated as satisfactorily with alternating current as with direct current. The type SC motor is of the same general construction as the single-phase alternating-current railway motor and operates on the same principle. It has long been known that an ordinary direct-current series motor would operate with alternating current, although the operation was not in general commercially satisfactory. The various difficulties, however, have now been successfully overcome.

The performance of these motors is illustrated by the curves in Figs. 1, 2, 3 and 4. It should be noted that the characteristic curves of both the 25 and 60-cycle motors are of the same general shape as those of direct-current series motors. The torque depends entirely on the current, a given current producing a certain torque regardless of whether the motor is running at full speed or any reduced speed. The speed curves are somewhat steeper than those of direct-curent motors, the speed falling off more rapidly with heavy loads and increasing more rapidly with lighter ones. This effect is a function of the frequency of the supply circuit and is consequently much more noticeable in the 60-cycle motors than in those designed for 25 cycles. Even the former, however, will produce a maximum torque of several times full-load torque.

The external appearance of the motors is similar in general to that of direct-current motors, and may be seen in Figs. 5 and 6. The principal constructional difference between these motors and direct-current motors, is the magnetic circuit, which is built up of annular punchings having poles projecting inward. These punchings are held together in a cast-iron frame. The frames are made solid and the armature is put in and taken out endwise. Another difference is the auxiliary field winding (which in reality forms a part of the armature circuit), which is wound in slots in the pole pieces. The object of this winding is to improve the power factor (and hence the maximum torque) by neutralizing the self-induction of the armature.

The 25-cycle motors are wound for a nominal voltage of from 200 to 220, and the 60-cycle motors for a voltage of 110 to 125. Speed control, under the direction of the operator, can be obtained by any method that changes the impressed voltage. With alternating current there are several ways of doing this. The simplest method, however, is by means of a rheostat such as is used in controlling direct-current series motors. On account of its simplicity this method has been adopted as standard, and the

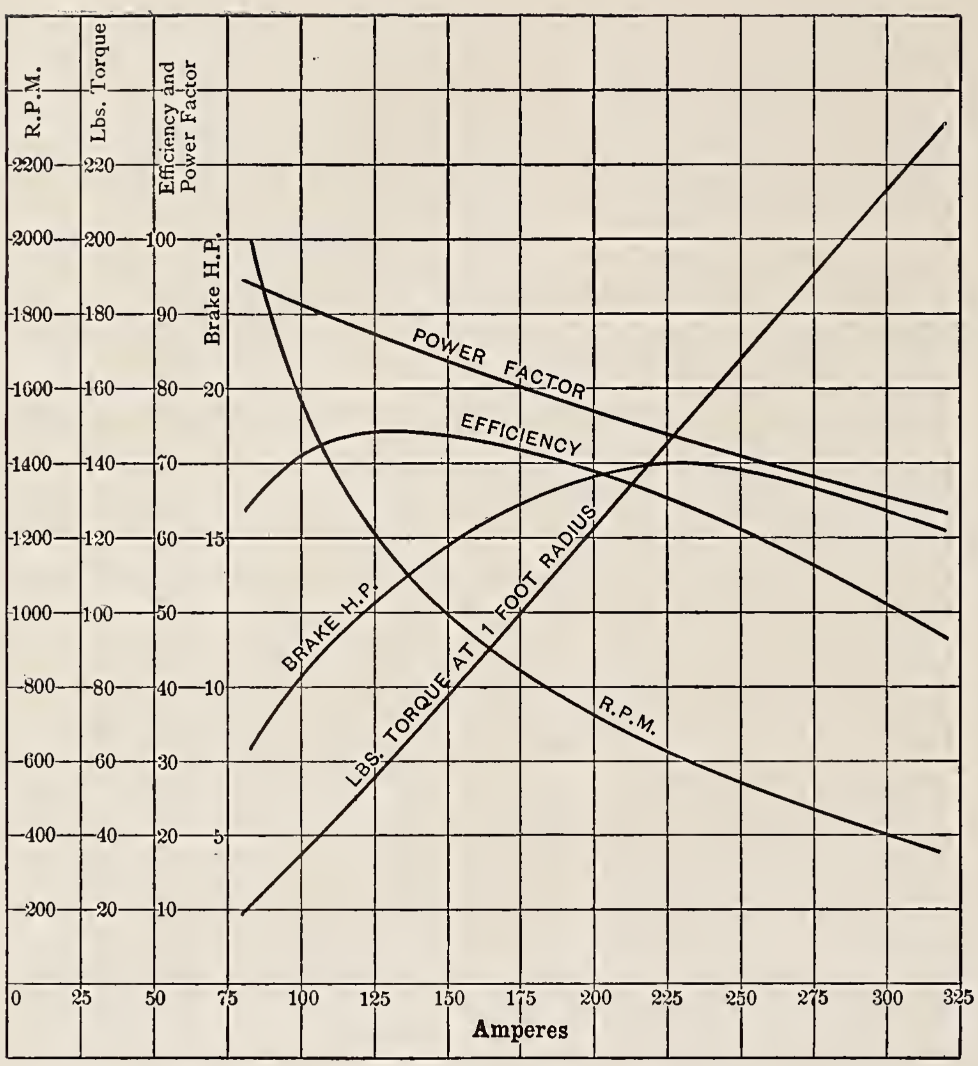


FIG. 4.—PERFORMANCE CURVES OF NO. 3, 60-CYCLE, TYPE SC MOTOR

controllers and resistances that are used are of the same general type as for direct-current motors of the same current capacity.

The controller used with the No. 1 motor is of the dial or face-plate type, the contacts being mounted radially on a flat vertical surface. This controller is shown in Fig. 9. For the remaining sizes, controllers of the commutator type are used. In these the contacts are mounted around the edge of a soapstone disc or cylinder. This type of controller is shown in Fig. 7. Both types of controllers have the necessary resistance mounted within the controller frame. Both types also have four radial rocker arms, each carrying a set of contact fingers. These four arms are moved together by means of a handle or through a system of bell cranks and levers. The operating rod can be connected to either the right or left-hand side of the rocker arm, so that two controllers may be mounted face to face or back to back as desired. A single movement to right or left applies or reverses the current. The circuit is broken at four different places at the same time, thus diminishing the arc.

The motors operating the hoists of a crane or similar machine are usually provided with automatic brakes, which serve to hold the load in position when current is cut off from the motors. A complete line of such brakes has been designed for use with these motors. These brakes are similar, in general, to those used with direct-current motors or with alternating-current induction motors. They consist in general of a brake wheel, mounted on an extension of the motor shaft at the commutator end, and a set of brake shoes, levers and magnet coils carried on the front end bracket of the motor. When no current is applied to the motors, the brake shoes are applied to the brake wheel by the action of gravity on a weight attached to the brake shoes and to the armature of the brake magnet by means of a bell crank lever. As soon as the current is applied to the motors the circuit of the brake magnet is closed, the magnet lifts its armature and the weight and thus releases the brake.

The windings of the brake magnet are controlled by means of a small switch mounted on the face of the controller. When the controller is moved to the first notch this switch is closed automatically and current flows through the brake magnet. When the controller is thrown to the open-circuit position the brake magnet circuit is also opened and the brake is thus locked by the weight. An additional trolley is required across the main frame of the crane for each brake equipment.

Since this type of motor will probably find its greatest field, at least for the present, in the operation of cranes, the special auxiliary

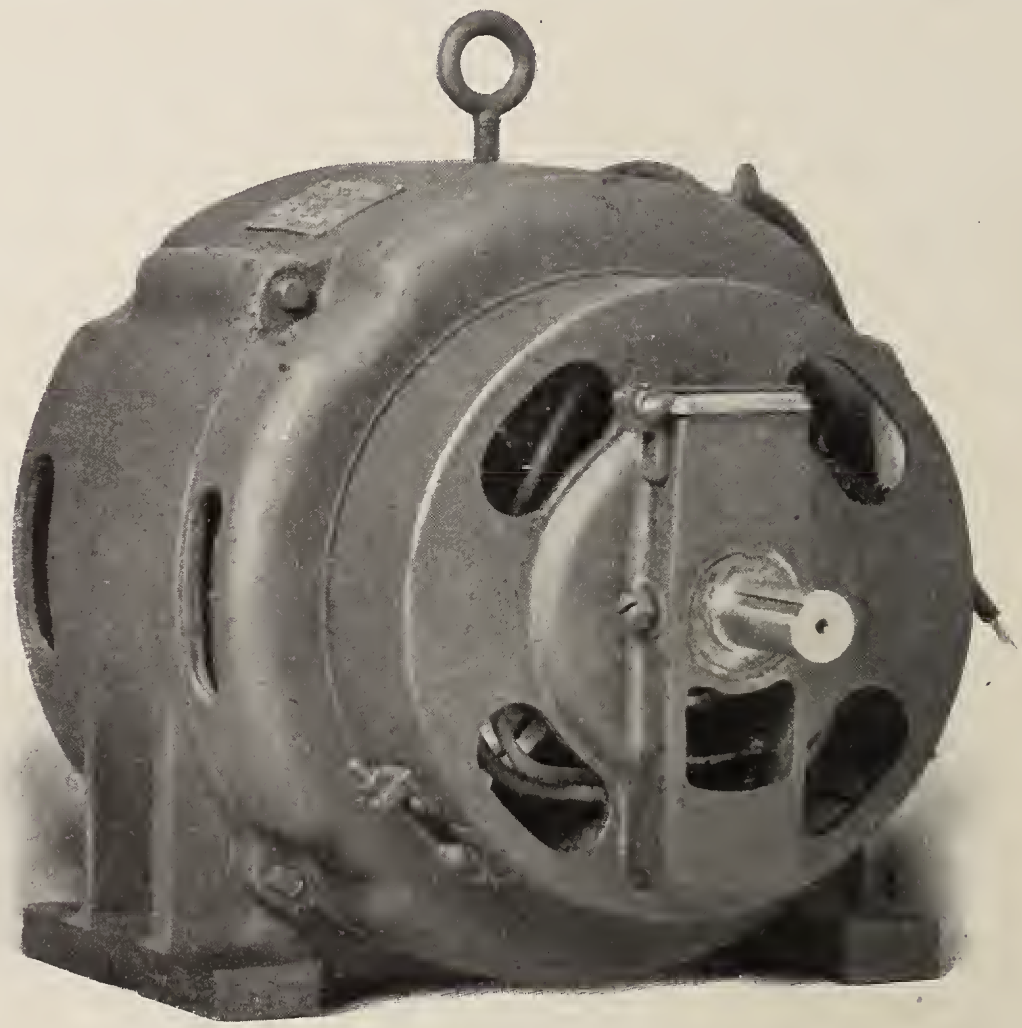


FIG. 5.—A FRONT VIEW OF THE NO. 2, TYPE SC MOTOR

FIG. 6.—A REAR VIEW OF THE MOTOR SHOWN IN FIG. 5

devices, such as controllers, brakes, etc., which have been described above, have been designed for use in connection with the motors for crane service. The same auxiliary devices, however, with possibly slight modifications, are of course applicable to any other purpose.

Where a number of these motors are operated from a poly-phase system, it will be well to connect some to one phase and others to other phases, in order that the current drawn from any one phase shall not be sufficient to unbalance the circuits. An exact balancing is not necessary in such cases, particularly where induction motors are operated from the same system, as in general the induction motors will tend to preserve a balance by taking more current from the lightly loaded phases and less from the heavily loaded ones.

In general, the advantages of these motors for crane service and similar work will be evident at once when it is understood that they have the same characteristics as direct-current series motors. The facts, however, may be more readily seen from the following example:—

Suppose a 10-ton crane is required, which most of the time, however, will be lifting weights of only five tons or less, and suppose the desired speed with the ordinary weight of five tons is 33 feet per minute. The total work required for lifting the weight will then be 330,000 foot-pounds, or 10 H. P., and since the efficiency of the mechanism will probably not exceed 50 per cent., an output of 20 H. P. at the motor shaft will be required. The No. 4, 25-cycle, type SC motor, at 20 H. P., runs at a speed of 980 revolutions per minute, and develops a torque of 106 pounds at one foot radius on its shaft. If the crane is now called upon to lift 10 tons, which may happen occasionally, a torque of 212 pounds will be required at the motor shaft, and, under these circumstances, the motor will run at 680 revolutions per minute with an output of approximately 28 H. P., and the speed of the load will be approximately 23 feet per minute. Since such a heavy load is lifted only occasionally, this drop in speed is of small consequence.

If a standard induction type crane motor were used, and arranged in the same way to lift five tons at a speed of 33 feet per minute, this motor would develop 20 H. P. at its

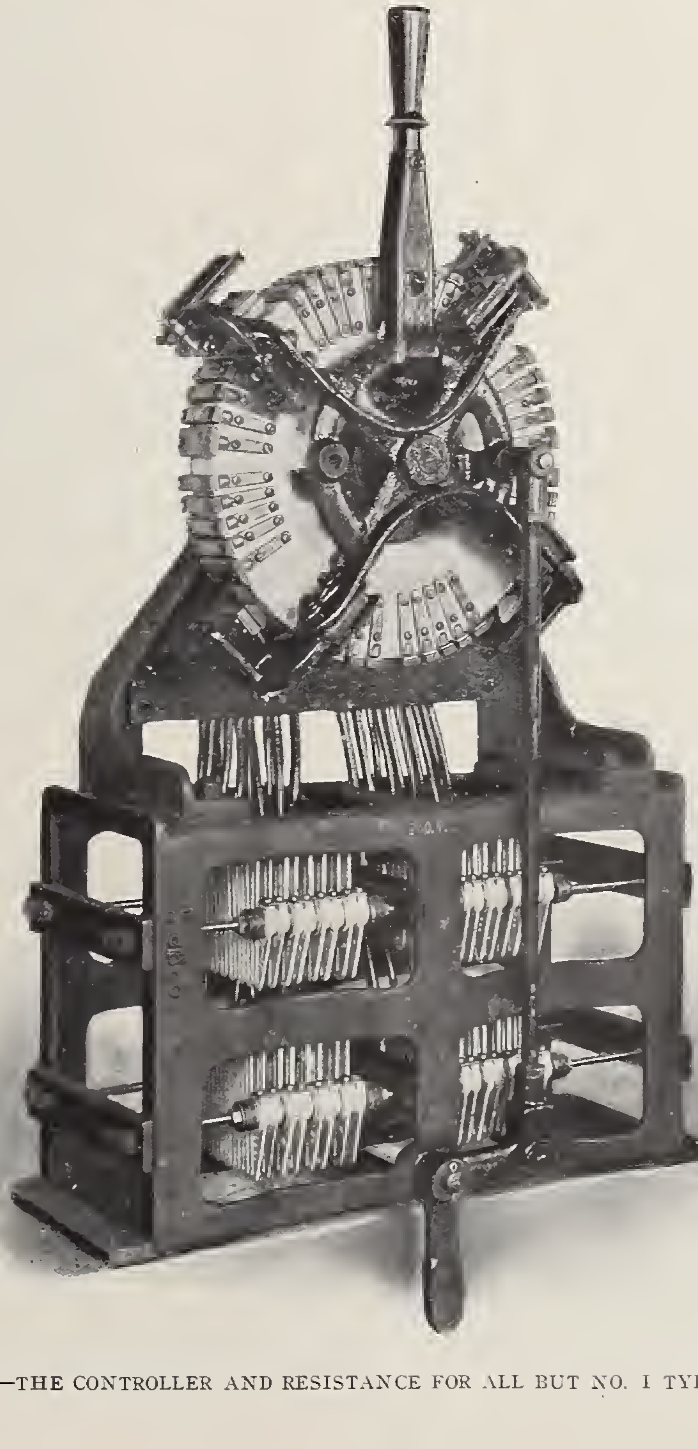


FIG. 7.—THE CONTROLLER AND RESISTANCE FOR ALL BUT NO. I TYPE SC MOTOR

shaft with a torque of 160 pounds and a speed of 700 revolutions per minute. In lifting the 10-ton weight, however (requiring double the torque for the five tons), the induction motor would still run at 640 revolutions per minute, exerting approximately 37 H. P., and the speed at which the load was lifted would be approximately 30 feet per minute. It is thus evident that if an induction motor is used it must be capable of exerting 37 H. P., while a series motor capable of exerting only 28 H. P. will suffice, and the only difference in the service performed by the crane in the latter case will be the fact, already mentioned, that the speed of lifting drops off when the occasional very heavy loads are applied.

Again, if only a very small load is to be lifted, the speed of the series motor rapidly increases, so that, if desired, small loads may be handled very quickly when circumstances permit. With the induction motor, however, the speed of lifting the weights and moving the crane will be practically the same with no load as with the maximum.

In general, cranes and similar classes of machinery have to be installed capable of handling maximum loads much heavier than the loads that they are handling the majority of the time, and it will be readily seen from the above example that if type SC motors are used instead of induction motors, not only will the general performance be more flexible and satisfactory, but a smaller motor will suffice, and a considerable saving in power consumption may be effected.

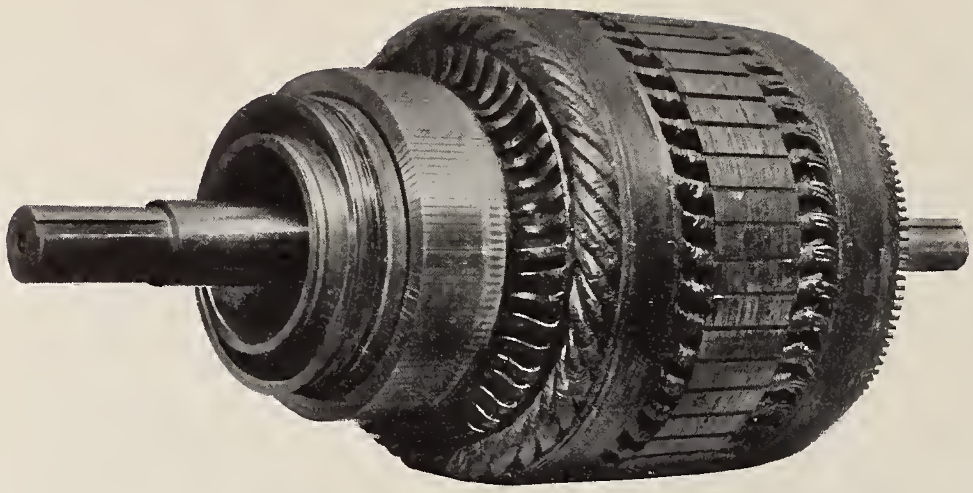


FIG. 8.—THE ARMATURE OF THE MOTOR SHOWN IN FIG. 5

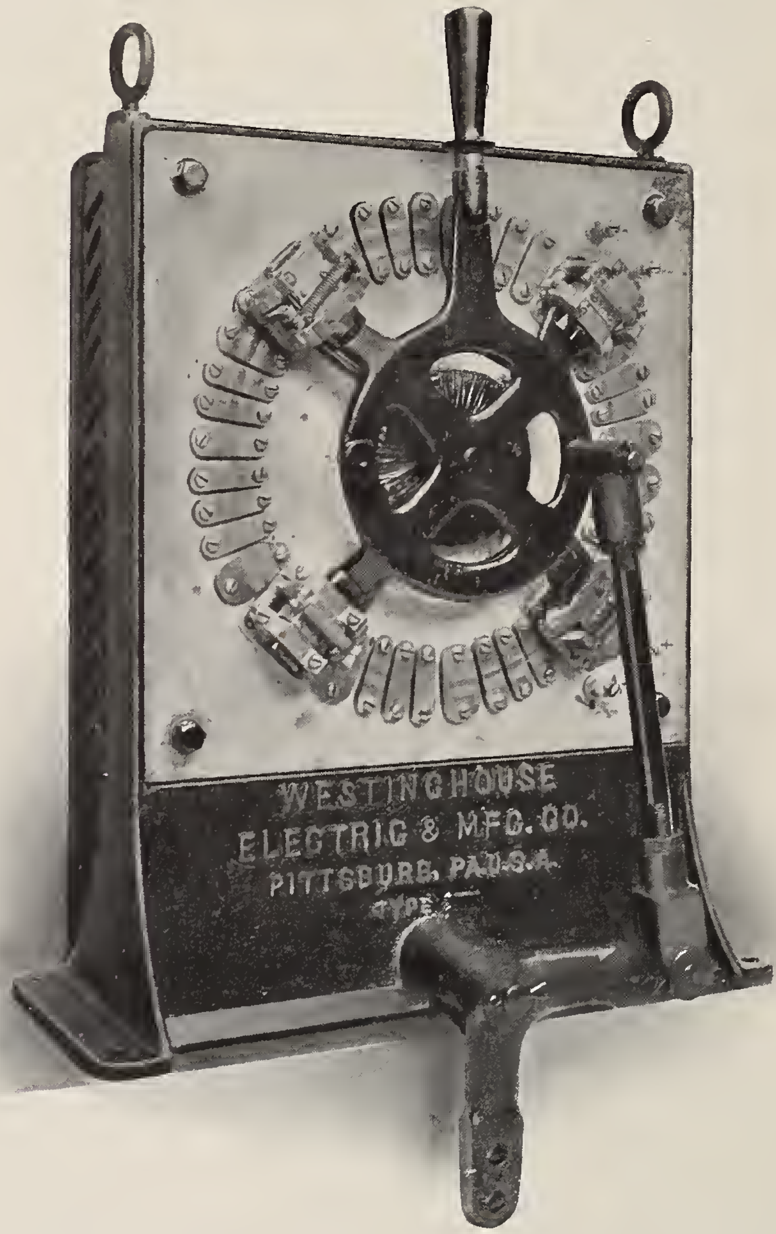


FIG. 9.—CONTROLLER AND RESISTANCE FOR NO. 1 TYPE SC MOTOR

A New Electric Railway to Compete with a Steam Road

It is reported that arrangements have been completed for the construction of a direct electric railway between Hartford, Conn., and Worcester, Mass., a distance of 60 miles, which is about 25 miles less than the present rail distance by the Boston & Albany steam railroad. A branch from Springfield is also proposed, which will give a short line between that city and Worcester.

The projectors, a Boston firm who built and operate the Boston & Worcester Street Railway, have secured control of the Hartford, Manchester & Rockville tramway, which extends from Hartford to Rockville, 18 miles, and that will form part of the projected freight line between Hartford and Worcester. It is stated that the fare for the 60 miles between those points will be 85 cents, compared with $1.75, the present fare on the steam road, and that the running time will be three hours.

In connection with the existing electric railway from Worcester to Boston it is expected that the trip from Hartford to Boston will be made in five hours, and that the fare will be $1.30, against $2.75 by the steam road. From Springfield to Boston the electric fare is to be 90 cents, against $2.23 by the steam road. About 38 miles of road will have to be built to complete the electric line between Hartford and Boston.

An electrolytic lead refinery is in operation at the Canadian Smelting Works, Trail, B. C., producing pig lead, lead pipe, sheet lead, etc. In 1904 19,000 tons of lead were produced, as against 9,070 tons in the previous year, but the output was a long way behind the maximum of 31,584 tons in 1900.

BATTERY PARK HOTEL, THE INSTITUTE'S HEADQUARTERS AT ASHEVILLE

The American Institute of Electrical Engineers

The Convention at Asheville, N. C., June 19-23

THE twenty-second annual meeting of the American Institute of Electrical Engineers was held this year at Asheville, N. C., during the week which began on Monday, June 19. The meeting was one of the most successful in the history of the organization, due primarily to the warm hospitality and lavish entertainment from the people of Asheville and the local committee, and also to the most excellent series of papers presented. The headquarters of the Institute were at the Battery Park Hotel, and it was there that the opening session was held on Monday morning, June 19.

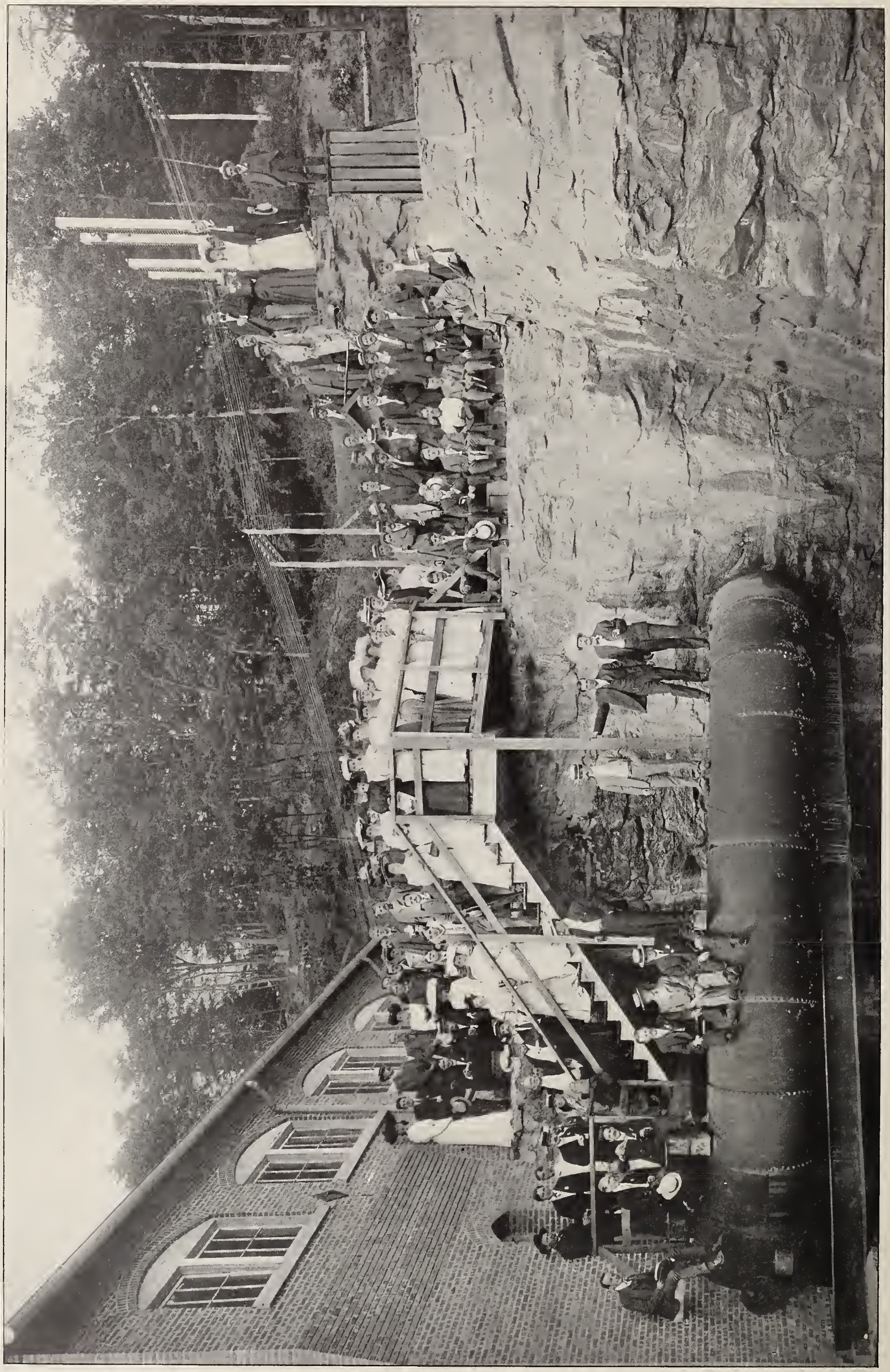
The assembly was in the ballroom of the hotel, and was called to order by President John W. Lieb, Jr. Mayor A. S. Barnard, of Asheville, welcomed the guests in a brief address, to which President Lieb responded, following with his presidential address. This had for its topic the organization and administration of national engineering societies, and was replete with interesting facts and figures bearing on the subject.

The first regular paper of the meeting was by Dr. Charles P. Steinmetz on "High-Power Surges in Electrical Distribution Systems of Great Magnitude." This was of great value, being one of the first attempts at a theoretical discussion of effects on other parts of the circuits caused by a disruptive discharge, and the consequent setting up of wave trains or surges and the enormously increased voltage due thereto. Dr. Steinmetz also presented a discussion of "The Constant-Current Mercury-Arc Rectifier." This was a very thorough exposition of the subject.

These papers were followed by one by Percy H. Thomas on "An Experimental Study on Commercial Transmission Lines of the Rise of Temperature Due to Static Disturbance, such as Switches, Grounding, etc." The writer showed that the effect of static disturbance of any kind caused a concentration of potential on the outer portions of the conductors connected to the circuit. He also claimed that as a matter of experience serious damage resulted from local concentration of potential much less frequently than would be expected.

At the Monday evening session Henry W. Fisher read a paper giving some new data relative to a change of insulation and capacity of

AN ASHEVILLE EXCURSION POINT



A GROUP OF MEMBERS AND GUESTS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AT THE DAM AND POWER HOUSE OF THE WEAVER POWER COMPANY, ON THE FRENCH BROAD RIVER, NEAR ASHEVILLE

THE DAM AND CANAL OF THE W. J. WEAVER POWER COMPANY, NEAR ASHEVILLE

conductors with temperature, and also of the variation of heat-conducting properties of insulating substances as compared with air.

"Methods of Measurement of High Electrical Pressures," by S. M. Kinter was the next paper on the list, its purpose being briefly to summarize the various methods of high-pressure measurement at present employed, pointing out the respective advantages and faults of these methods, and then to describe a new type of Westinghouse static voltmeter.

John W. Howell, of the General Electric Company's Lamp Works, followed with a paper criticising some remarks made by Col. E. B. Crompton at the International Electrical Congress at St. Louis last September. Col. Crompton had stated that British practice showed that 220-volt lamps were as efficient as 110-volt lamps. Mr. Howell took issue with this and showed by a test of a number of lamps obtained abroad that this was hardly correct, the foreign lamps being of rather a high wattage per candle-power, and most of them would, when burned at rated voltage, give considerably lower candle-power than their commercial rating.

During the afternoon the institute members and guests drove through the famous Biltmore estate of George Vanderbilt.

Tuesday, June 20, "Railroad Day," as it had been designated, was given up to a series of papers on electric traction problems. "Three-phase Traction," by F. M. Waterman, the first paper presented, was a discussion of the problem of three-phase traction as contrasted with single-phase.

C. DeMuralt followed with a paper on "Heavy Traction Problems in Electrical Engineering," this being an excellent discussion of the problems which arise in attempting to handle heavy traffic conditions by electricity. The light street railway work has been very well worked out, but with what is coming with heavy traffic we are less familiar, and Mr. DeMuralt took up this line of discussion.

Wm. McClellan next presented a paper on "The Choice of Motors in Steam and Electrical Practice." To properly describe this paper, the word "traction" should be substituted for "practice," the paper being given up entirely to a discussion of the motors required for electric traction as applied to the various locomotive types of traction machinery in common use on steam railways.

"Electrical Features of Block Signaling," by L. H. Thullen, was a very timely and well presented paper descriptive of the systems, with especial reference to the lock and block and automatic system.

It has been only within the last decade that electrical science has played any important part in block-signaling. Previous to that time the only use for electrical apparatus in signaling was in the form of a few batteries for the track circuit, and for the operation of pin-valve magnets in the electropneumatic system of signaling and interlocking. But in the past few years electricity has come steadily into use as a means of transmitting the operating power, until at the present time it is the prime element in signaling.

A brief sketch of the older methods of signaling was first presented, as they are still in use, and therefore not without interest.

S. T. Dodd's paper on "Weight Distribution on Electric Locomotives as Affected by Motor Suspension and Draw-Bar Pull" was an elaborate discussion of the effect of draw-bar pull on the pressure or loads on different wheels and consequent tractive force which it was possible to obtain.

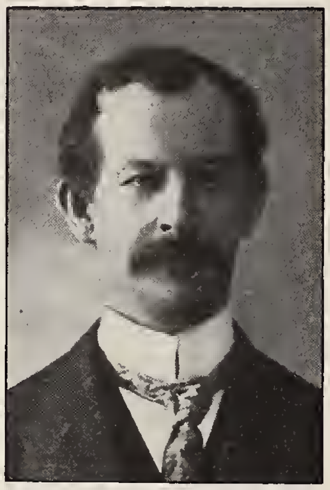
For Tuesday afternoon the local committee had arranged a visit to the Weaver Power Company's plant on the French Broad River, about seven miles below Asheville. This plant has a dam giving about 10 feet head, and by means of a long head-race obtains a total of 22 feet 6 inches. The installation consists of two units,—one Bullock and one Westinghouse,—of 750 H. P. each, three-phase, sixty cycles, and 660 volts. Through the courtesy of Mr. Weaver, the president of the company, a delightful lunch was served there. The power company furnishes power to Asheville, Biltmore, and a number of manufacturing establishments in the vicinity.

On Tuesday evening a ball was given to the Institute by the members of the local committee. This was an exceedingly enjoyable affair.

Wednesday morning was given up to another business meeting. This day had been named "Electrical Design Day," and the papers presented were accordingly devoted to design problems. "Limits of Injurious Sparking in Direct-Current Commutation," by Thorburn Reid, and "The Design of Induction Motors, with Especial Reference to Magnetic Leakage," by A. C. Adams, were first in order, and were followed by a paper on "Limitations in Direct-Current Machine Design," by Sebastian Senstius. This was a very interesting contribution, so far as it went; but, as was pointed out in the subsequent discussion, it was a

S. S. WHEELER, President

CHAS. A. TERRY, Vice-President



TOWNSEND WOLCOTT Vice-President

G. S. DUNN, Vice-President

C. C. CHESNEY, Manager

NEW OFFICERS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

particular discussion of a special case. In other words, the limitations could scarcely be said to apply to anything but a very special case of direct-current work. As Dr. Steinmitz remarked in the discussion, the limitations were far out of the way for general application, and must be more carefuly worked out and investigated in detail before they can be trusted.

A paper on "Eddy Currents in Large Slot-Wound Conductors," by A. B. Field, read by title, was followed by one on "A New Instrument for the Measurement of Alternating Currents," by E. F. Northrup. This was one of the most important papers of the meeting.

The instrument and methods of measurement described in this paper were developed to meet the frequent need of means for easily and accurately calibrating alternating-current instruments,—ammeters and voltmeters, whatever their capacity; also to suggest an inexpensive method of measuring with high precision very large alternating currents regardless of their wave form or frequency. Incidentally, the instrument and methods should prove sufficient for the accurate measurement of currents of very high frequency where ordinary methods would not be applicable.

A further object kept in mind was to make it possible to utilize an installation of a direct-current potentiometer outfit, to measure alternating currents and pressures with nearly equal facility and precision.

The instrument and the methods of using it have been successful because the following important features have been realized:—(*a*) It is used as a *zero instrument*, and does not depend upon any calibration or determination of any constant of the instrument; (*b*) it operates with extreme sensitiveness, and being perfectly "dead-beat," is adapted to work with fluctuating currents; (*c*) it may be used with or without low-resistance shunts; when used with them, it has an unlimited upward range of current measurement; and when used without them, its lower range is down to from two to five milliamperes; (*d*) as the operation of the instrument depends upon the heating effect of currents, it is wholly independent of wave-form and frequency.

ON THE SWANNANOA RIVER, NEAR ASHEVILLE

Wednesday afternoon was given up to a very enjoyable trolley ride to Riverside Park, winding up with afternoon tea at the golf links of the Swannanoa Golf Club. For the evening a banquet had ben arranged by the local committee. This was held at the Battery Park Hotel, and was thoroughly enjoyed. Mr. T. Commerford Martin, as usual, acted as toastmaster, the several toasts and speakers being:—

"Our First Visit South," John W. Lieb, Jr., President A. I. E. E.; "Our Visitors," Alfred S. Barnard, Mayor of Asheville; "The Institute," Dr. Schuyler S. Wheeler, President-elect A. I. E. E.; "Industrial Developments of the South," John H. Finney, member local committee; "Our Technical Institutions," Dr. Samuel Sheldon; "Theory and Practice," Dr. C. P. Steinmetz, Past President A. I. E. E.; "Utilization of Natural Resources by Electricity," Dr. F. A. C. Perrine. The hit of the evening was a poem read by Dr. Sheldon, of the Brooklyn Polytechnic Institute.

Thursday morning was given up to the reading of papers. Two particularly important contributions were





CALVERT TOWNLEY, Manager — B. GHERARDI, Manager — C. L. EDGAR, Manager — GEO. A. HAMILTON, Treasurer — R. W. POPE, Secretary

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presented at this session, one on "The Water Powers of the Southeastern Appalachian Region," by F. A. C. Perrine, and one on "A New Induction Generator," by Wm. Stanley. Dr. Perrine described the various rivers from the James south, including the Staunton, Dan, Cape Fear, Catawaba, Yadkin or Wateree, Oconee, Ocmulgee, and other water-power rivers of the South.

In the discussion of this paper, Mr. L. S. Randolph pointed out the varying rainfalls in different seasons, that in one year the minimum rainfall would come in winter, while in another it might come in summer. Mr. Weaver, president of the Weaver Water Power Company, also took part in the discussion, calling attention to the fact that the flood rise east of the Alleghenies was sometimes as much as 37 feet, whereas west of the Alleghenies it was much less. On the French Broad River at Asheville the maximum flood rise was only 7 feet, and they were entirely free from anchor ice. These advantages, taken in connection with free equable temperature and moist condition of the atmosphere, made the spinning of fine yarn there a very easy proposition.

In a paper entitled "The Development of the Ontario Power Company," P. N. Nunn described another of the Niagara Falls power companies' plants. This one is on the Canada side, close to the Falls, the essential element of difference

PARK SQUARE, ASHEVILLE

BILTMORE, NEAR ASHEVILLE, THE ESTATE OF GEORGE W. VANDERBILT

from other Niagara plants being that the development station with the generators and water-wheels is down on the river bank, while the distribution station with its switchboards, etc., is on the top of the cliff.

Charles A. Perkins, professor of electrical engineering at the University of Tennessee, illustrated a very simple device for finding the slip of an induction motor by means of a tongue which is caused to vibrate by means of a magnet connected in series with the motor whose slip it is desired to measure. To the motor shaft was connected a rotating disk containing a slot. Looking at the vibrating tongue through this slot in the rotating disk the slip was shown by a very slow rate of vibration of the tongue. There should be as many slots on the disk as there are positive poles on the motor, so that each time the slip passed one pole the tongue apparently vibrates once.

Next in order was a paper entitled "Notes on the Power Factor of the Alternating Current Arc," by Geo. D. Sheppardson, which was read by title.

"A New Carbon Filament," by John W. Howell, proved to be an exceedingly valuable paper. Mr. Howell described the filament as being manufactured of carbon by firing in an electric furnace. The filament is somewhat shorter than the ordinary horse-shoe filament, and gives a power consumption of two and one-half watts per candle-power.

An important paper of the meeting was that by Wm. Stanley, assisted by G. Facciolo, on "Alternating Current Machinery,—Induction Alternators." By varying the current in the fields of the exciter a very low frequency is obtained in the alternator field. Mr. Stanley was enabled to obtain any desired frequency within certain limits in an induction alternator at constant speed. This very interesting phenomenon obtains one of its most valuable qualities from the fact that the reverse of the proposition means that with a constant frequency a variable-speed motor can be obtained by varying the frequency of the exciter. This has been one of the great drawbacks to all synchronous motor systems.

Thursday afternoon a most enjoyable visit was made to Biltmore to hear an organ recital at All Souls' Church. In the evening the Institute was entertained at a "smoker" at the Albemarle Club.

On Friday, through the courtesy of the Southern Railway, an excursion was given to the Institute through the Sapphire country to Lake Toxaway.

All were loud in their praises of the convention, the success of which was due to the members of the local committee, and for many years pleasant memories will hang around the names of Waddell, Finney, and Keeler.

Among those present during the week of the convention were:—

Adams, C. A., Green Harbor, Mass.
Anderson, Edw. H., Schenectady, N. Y.
Anson, F. R., New York, N. Y.
Anson, Mrs.
Arnold, Bion J., Chicago, Ill.
Arnold, Miss Maud L.
Asbury, O. F., Charlotte, N. C.
Bahnson, F. F., Winston-Salem, N. C.
Balsley, A., Atlanta, Ga.
Guest or guests.
Bates, F. C., New York, N. Y.
Beckett, B. B., West Point, Miss.
Bel, U. S., Atlanta, Ga.
Blakeslee, H. J., Hartford, Conn.
One guest.
Bonyun, M. Evan, Atlanta, Ga.
Bowden, Z. M., Mulberry, Fla.
Brooks, Morgan, Urbana, Ill.
Brown, Warren D., New York, N. Y.
Browne, Wm. Hand, Jr., New York, N. Y.
Bryant, Fred L., Spartanburg, S. C.
Carty, J. J., New York, N. Y.
Case, W. M., Clarksvile, Tenn.
Clifford, H. C., Boston, Mass.
Coho, H. B., New York, N. Y.
Coho, Mrs.
Coles, H. A., Atlanta, Ga.
Coles, E. P., Philadelphia, Pa.
Collett, S. D., New York, N. Y.
Collier, W. R., Atlanta, Ga.
Conant, S. M., Atlanta, Ga.
Crocker, F. B., New York, N. Y.
Davis, E. E., Savannah, Ga.
Dion, A. A., Ottawa, Canada.
Dodd, S. T., Schenectady, N. Y.
Donshea, W. I., New York, N. Y.
Dunn, Gano S., Ampere, N. J.
Eastman, G. N., Chicago, Ill.
Eastman, Mrs.
Eastwood, A. C., Cleveland, O.
Edwards, J. P., Augusta, Ga.
Faccioli, G., Great Barrington, Mass.
Finney, John H., St. Louis, Mo.
Finney, Mrs.
Fisher, M. W., Pittsburgh, Pa.
Ford, A. H., Atlanta, Ga.
Forsythe, W. C., Tallahasse, Fla.
Frank, John J., Schenectady, N. Y.
Fries, J. E., New York, N. Y.
Gale, F. H., Schenectady, N. Y.
Goldsborough, W. E., New York, N. Y.
Guests (probably two).
Good, Miss G., Bronxville, N. Y.
Hadley, F. W., Atlanta, Ga.
Hall, J. H., Marion, N. C.
Hammatt, C. S., Jacksonville, Fla.
Harris, George H., Birmingham, Ala.
Hayden, J. Le R., Schenectady, N. Y.
Hering, Carl, Philadelphia, Pa.
Hodges, G. H., New York, N. Y.
One guest.

Hodges, W. L., Atlanta, Ga.
Hopping, G. W., New York, N. Y.
Howell, John W., Newark, N. J.
Howell, Mrs.
Hubley, G. W., Louisville, Ky.
Hubley, Mrs.
Jennens, W. S., Ann Arbor, Mich.
Johnson, Chas S., Springfield, O.
One guest.
Karapetoff, V., Ithaca, N. Y.
Karapetoff, Mrs., Ithaca, N. Y.
Keeler, J. P., Ashevile, N. C.
Kintner, S. M., Pittsburgh, Pa.
Knox, F H., Pittsburgh, Pa.
Kruesi, J. J., Chattanooga, Tenn.
La Fever, Chas A., Battle Creek, Mich.
Lake, Edw. N., Chicago, Ill.
Lanier, Alex. C., Knoxville, Tenn.
Lansing, V. R., New York, N. Y.
Laxton, F. M., Atlanta, Ga.
Laxton, Ralph R., Scranton, Miss.
Lee, W. S., Jr., Charlotte, N. C.
Leonard, H. Ward, Bronxville, N. Y.
Leonard, Mrs.
Lieb, J. W., Jr., New York, N. Y.
Lieb, Mrs.
Loutey, G. S., League Island, Pa.
McClellan, Ross St. J., Schenectady, N. Y.
Martin, J. Frank, Danbury, N. C.
Martin, T. C., New York, N. Y.
Mayer, Geo. M., Chicago, Il.
One guest.
Moore, W. E., Connellsville, Pa.
Moses, Percival R., New York, N. Y.
Moses, Mrs.
Nash, L. R., Savannah, Ga.
Northrup, E. F., Philalelphia, Pa.
Northrup, Mrs.
Nunn, P. N., Niagara Falls, N. Y.
Nunn, Mrs.
One guest.
Perkins, Chas. A., Knoxville, Tenn.
Perrine, F. A. C., New York, N.Y.
Perrine, Mrs.
Phelps, W. J., Detroit, Mich.
Pizzini, A. J., Richmond, Va.
Pope, R. W., New York, N. Y.
Potter, Henry M., New York, N. Y.
Randolph, L. S., Blacksburg, Va.
One guest.
Reed, Henry A., New York, N. Y.
Reed, Mrs.
Reid, Thorburn, New York, N. Y.
Rice, Calvin W., New York, N. Y.
Rich, Sidney L., Atlanta, Ga.
Richardson, J. W. A., New Orleans, La.
One guest.
Riggs, N. M., Clemson College, S. C.
Ross, Edw. N., Philadelphia.
Ros, Norman, Cincinnati, O.
Rossman, J. G., Atlanta, Ga.
One guest.
Sachs, Joseph, Hartford, Conn.
Sachs, Mrs.

Sampson, F. D., Charlotte, N. C.
Scheffler, Fred A., Glen Ridge, N. J.
Scheffler, Mrs.
Schmidt, F. E., New York, N. Y.
Schneider, C. A., Schenectady, N. Y.
Schoen, A. M., Atlanta, Ga.
Guests (one or two).
Schreiber, H. V., Augusta, Ga.
Schwartz, Carl, New York, N. Y.
Schwarz, E. H., New York, N. Y.
Seaman, E. H., Wantagh, Long Island.
Seidell, Thos. G., Atlanta, Ga.
Senstius, Sebastian, Cincinnati, O.
Sever, G. F., New York, N. Y.
Sharp Clayton H., New York N. Y.
Shaw, J. A., Montreal, Canada.
Sheldon, Samuel, Brooklyn, N. Y.
Simon, Arthur, Milwaukee, Wis.
Sirrine, J. E., Greenville, S. C.
Smith, Samuel J., Charlotte, N. C.
Spear, Jas. O., Jr., Atlanta, Ga.
Spellmire, W. B., Pittsburgh, Pa.
Stanley, Wm., Great Barrington, Mass.
Stanley, Mrs.
Steinmetz, W. H., Atlanta, Ga.
Steinmetz, C. P., Schenectady, N. Y.
Stone, E. W., Asheville, N. C.
Scott, H. G., New York, N. Y.
Strong, R. P., New Orleans, La.
Suhr, O. B., Niagara Falls, N. Y.
Taylor, Edward R., Penn Yan, N. Y.
Taylor, Mrs.
Thomas, P. H., New York, N. Y.
Waddell, Charles E., Biltmore, N. C.
Walker, Wm. L., New York, N Y.
Walters, W. L., Milwaukee, Wis.
Waterman, F. N., New York, N. Y.
Wells, E. J., Richmond, Va.
Wells, Mrs.
Werth, M. F. M., Richmond, Va.
Wheeler, Schuyler Skaats, Ampere, N. J.
Williams, R. Neil, Schenectady, N. Y.
Willis, E. J., Richmond, Va.
Willis, Mrs.
Wills, H. Le Waque, Atlanta, Ga.
Winship, W. E., New York, N. Y.
One guest.
Wotton, James A., Atlanta, Ga.
Wotton, Mrs.
Wrigley, Geo., Atlanta, Ga.
Yundt, Geo. J., Atlanta, Ga.

In 1885 the long-distance mileage of the Bell Telephone Company in Canada was 2000 miles; to-day it is 32,000 miles. In 1895 there were 29,000 subscribers; now there are 66,160.

Nuggets from the Asheville Convention

Of the American Institute of Electrical Engineers

THE injury done by sparking at the brushes of a direct-current dynamo is not due to the current jumping across the gap between the segment and the brush, but is done while the brush is in contact with the segment; the copper of the segment being first melted and then volatilized by the concentration of current energy at one or other of the segment edges. With perfect commutation the total energy developed over the contact surface is a minimum, and every part of the contact surface receives an equal amount of energy. On this principle the question of sparking is simply a question of the temperature of the segment while it is under the brush. * * * * There are, or used to be, many direct-current generators which sparked continuously without visible injury to the commutator. In fact, all our information on this subject goes to show that such a spark injures, not the conductor, but the insulation, which it pierces or disrupts. The main energy of such a spark must clearly exist in the space across which it jumps, since practically the whole difference of pressure exists in this space. When this space is filled with air it is the air that receives the energy of the spark; if it is occupied by some solid insulating medium, it is this insulation that receives the energy and is pierced or destroyed. The lightning stroke injures only the insulators in its path, unless the volume of current be too great.

Thorburn Reid.

The phenomena of commutator and brush sparking, glowing, spitting and picking up copper of D. C. machines offer a great field for speculation. Nothing definite is yet known about the causes that produce them. Bright, white sparks usually can be traced to a too high reactance pressure. These sparks do not seem to be harmful to the commutator. Glowing of the brushes appears when the armature reaction exceeds a certain limit. This reaction may be caused by the working current, and in addition by unbalanced currents going from one brush-stud to other brush-studs of the same polarity. Spitting appears to be the combined effect of high reactance pressure and considerable armature reaction. The sparks become yellowish or greenish, small explosions (spitting) take place under the brushes, causing carbon particles to escape into the air; the commutator loses its glassy appearance and becomes blackened. The picking up of copper at the contact surface of the brushes may take place at full-load and at no-load, which indicates that it is independent of the armature reaction. The effect may result from a steep magnetic fringe produced by a large air gap; a large electromotive force is generated in the coil under short-circuit, and an excessive current is set up, but not large enough to cause sparking and spitting. It is within the ability of the designer to prevent these commutator troubles by taking conservative values for the reactance pressure, the armature reaction, the current densities at the brush contact and the peripheral speed of the commutator.

Sebastian Senstius.

It seems that in an electric circuit containing distributed capacity and inductance, three distinct frequencies essentially independent of one another must be recognized:—First, the impressed frequency supplied by the generating system; second, the frequency of oscillation of the system, or natural period of the circuit, depending on the constants of the circuit, mainly the capacity and inductance, and the higher harmonies thereof which usually rather predominate; and third, the frequency of circuit disturbance which has no relation to impressed frequency or to the natural period, but depends upon the character of the disturbance. It appears as a system of waves traveling along the line, and results in static displays at the end of the line, that is, at the station switchboards. In its simplest form, as a single wave or impulse traveling along the circuit (frequently visible to the eye as a luminous streak), it probably appears when a moderate lightning flash or side discharge strikes the transmission line, and from there to the ground, giving, at the point of impact, a sudden rise of pressure against ground, immediately relieved by the discharge to ground. While this phenomenon is of itself rather harmless, its danger consists in the self-destruction forces that it may set into play.

C. P. Steinmetz.

In an electric arc the current is carried across the gap between the terminals by a bridge of conducting vapour consisting of the material of the negative pole, or the cathode, which is produced and constantly replenished by the cathode blast—a high velocity blast issuing from the cathode. An electric arc, therefore, cannot spontaneously establish itself. Before current can flow as an arc across the gap between two terminals, the arc flame or vapour bridge must exist, that is, energy must have been expended in establishing this vapour bridge. This can be done in the usual way by bringing the terminals into contact and so starting the flow of current, and then, by gradually withdrawing the terminals, derive the energy of the arc flame from the current; or, by increasing the voltage across the gap between the terminals so much that the electrostatic stress in the gap represents sufficient energy to establish a path for the current, that is, by jumping an electrostatic spark across the gap which is followed by the arc flame, as occasionally happens, for instance, in lightning arresters; or, by supplying the arc flame from another arc, an arc can be established between two terminals, as also occasionally happens when a switch opens or burns up, and its arc flame envelops the blades of another switch.

C. P. Steinmetz.

Brief consideration will show that the eddy currents in heavy conductors carrying alternating currents and surrounded on three sides by iron, are produced by flux crossing the slot transversely from a tooth through the body of the conductor, and that they take an elongated form, tending to follow along the top edge of the conductor throughout the length of the core, and return along the edge nearer the slot-root. The eddy currents themselves will produce magnetic flux which will react upon the whole system of currents, and the net

result in the conductor will be a current varying in density and phase at different depths. The density of transverse flux at any depth is practically determined by the slot width and total current in the slot below the transverse path considered; and generally the tooth saturation, even when carried high up, will have quite an insignificant effect. This is due in large measure to the fact that the flux, which is responsible for the saturation of the teeth, passes down both teeth in the same direction.

A. B. Field.

The writer long ago devised the following simple rule for predicting the flow of periodic currents in circuits when the phenomena of distribution were not entirely clear at first sight; namely, that periodic currents attempt to flow in a network of connected circuits, or in circuits possessing mutual induction, so as to produce the least possible magnetism (flow at such time and value as to destroy each other's fields).

Wm. Stanley.

The power factor of the alternating-current arc lamp is found to remain constant when the arc pressure is constant, whatever the range of current and whatever the wave-form of the impressed electromotive force. Likewise, when the length of the arc (measured by the image thrown by a lens) is maintained constant, the power factor of the arc is independent of changes in current and in wave-form of electromotive force applied to the lamp terminals. The quality of the carbons and the exposure of the arc to the air affect the power factor of the arc considerably.

Geo. D. Sheppardson.

In the contest for industrial supremacy which is continually being waged between sections of our country the ready availability of water-power in the South is certain to play no unimportant part. The conditions it must be observed are in all respects different from the conditions in other parts of the country. There is no location which can command the field, for within a comparatively short distance of each plant there is another location which may be developed and probably offer competition. The minimum flow is everywhere small and the floods are heavy, varying from 75 to 150 times the minimum. But, on the other hand, there is at hand a class of manufacturers who appreciate the value of water-power even when it is variable, and who are accustomed to providing themselves with steam auxiliaries. These conditions are, on the whole, favourable to the development of water-power on a large scale, but point to the necessity for effective management and a comprehensive plan for the development of a section of the water-powers of the Southeastern Appalachian region rather than the development of a single power.

Frederick A. C. Perrine.

The practical value of the ability to restore energy to the line possessed by the three-phase system (traction) has been the subject first and last of a considerable amount of discussion, the general conclusion of American engineers apparently being that, except for mountain roads with heavy traffic, it is an item of comparatively small consequence. * * * *

Eighteen years of experience have brought the direct-current system (traction) to a high state of development, while with only one case of serious working-out on a large scale, the three-phase system is showing results which, from the standpoint of effectiveness and economy, seem not inferior.

F. N. Waterman.

The greatest advantage which can be secured in trunk-line operation by the use of electricity in place of steam lies in the practically unlimited power which can be poured into an electric locomotive. This increased power can be used to haul far heavier trains than are now customary, up steeper graves and at higher speeds if desired. The technical characteristics of the three-phase alternating-current system are such as to make it pre-eminently suited for taking advantage of the situation, and its smaller cost of installation, with corresponding lower charges for interest, amortization, etc., allows the railway company to keep the full benefit of the resulting greater economy of operation. The three-phase alternating-current motor is probably the most robust and thoroughly mechanical piece of electrical machinery extant, and it may well be hoped that it will be used extensively in railroad work in the future.

Carl L. DeMuralt.

An ordinarily treated incandescent lamp filament when subjected to an external temperature of 3000 to 3700 degrees C. in a heated tube undergoes changes in appearance and its specific resistance is reduced as much as 80 per cent by the firing; its graphite coating looks as though it had been melted. Its cold resistance is reduced from 1000 to 200 ohms. Filaments thus treated are termed metallized filaments. They are much more stable at high temperatures than ordinary carbon filaments; they blacken the lamp very much less. They give a useful life (to 80 per cent. of initial candle-power) of about 500 hours at about 2.5 watts per candle-power.

John W. Howell.

Although entirely feasible to use the vertical-shaft turbine, and although restricted space at the power-house in question requires greatest floor economy, nevertheless horizontal units are employed on account of their freedom from step-bearings, their higher efficiency and their greater accessibility.

P. N. Nunn.

In the same manner as our laws of inductance have been built up step by step, and the limitations that apply in commercial circuits (such, for instance, as hysteresis in iron cores), have become gradually recognized and finally experimentally investigated quantitatively, so must our exact knowledge of static phenomena on commercial circuits be built up step by step, largely by experiment and experience, and their practical bearing on the design and operation of such circuits be finally determined. Furthermore, in view of the complex nature of static phenomena, and the difficulty of making measurements of the extremely rapidly varying currents and voltages involved, and of determining the exact facts in any case of serious accidental disturbance, or even in a case where careful preparation has been made beforehand, the complete knowledge and control of static phenomena in full-sized commercial circuits will be slow in coming.

Percy H. Thomas.

Generally speaking, from the point of view of reliability of operation, there is little choice between 25-cycle synchronous converters and 25-cycle motor-generators, although in a 60-cycle installation the advantage is decidedly in favour of the motor-generator. Motor-generators have another advantage over synchronous converters in that they are not so liable to hunt as the latter. From the operating engineer's standpoint, a motor-generator is preferable to a synchronous converter in almost every respect, except as to efficiency and cost, and even as to cost, a motor-generator is decidedly the cheaper for low voltages and larger outputs. * * * * The question as to which type of machine ought to be used in any given case can be decided only after every feature of the

situation has been duly considered. Broadly speaking, however, the tendency to-day is toward motor-generator sets in lighting systems and synchronous converters on traction systems. *W. L. Waters.*

It has been only within the last decade that electricity has played any important part in block-signaling. Previous to that time the only use for electrical apparatus in signaling was in the form of a few batteries for the track circuit, and for the operation of pin-valve magnets in the electro-pneumatic system of signaling and interlocking. But in the past few years electricity has come steadily into use as a means of transmitting the operating power, until now it is the prime element in signaling. * * * * *

Laymen usually believe that the rails of a track are less likely than any other part of a signal system to be struck by lightning, or to carry currents induced by lightning. Yet this is one of the serious matters with which signal men have to contend. The induction discharge between rails is considerable, and numerous relays have been burned out or injured by lightning, notwithstanding they were built in the best possible manner, and all of their parts had been tested at the factory with an alternating current of 5000 volts. *L. H. Thullen.*

It is difficult to predict at this time the maximum pressures that may ultimately be transmitted through cables. The experienced manufacturer can construct cables that will withstand very high pressure tests at the factory; but without subjecting such cables to pressures operating under working conditions for a long time, it is impossible to tell how they will withstand high pressures continually, and abnormally high ones occasionally.

All cables which are to be placed underground should be provided with lead covers, because, even if the insulating material of a cable be such that it may be submerged in water for an indefinite time without breaking down under pressure tests, nevertheless, unless lead-covered, it will sooner or later be injured by some destructive element in the ducts or manholes. *H. W. Fisher.*

In this country most large lamp consumers buy lamps on close specifications and make tests to see that the specifications are fulfilled. It is also a common custom in this country for consumers to buy samples of different lamps on the market and determine by test which makes are best. This forces lamp makers to mark their lamps very accurately for volts and candle-power, for any package may be tested in competition with lamps of other makers. *John W. Howell.*

Opportunities in the Electrical Business

THE prospects of large financial success of the engineering graduate are the same as those of the graduate of the college of medicine or of law. The great prizes are only for the few. A comfortable maintenance is for the majority, and the failures are no greater in number than in the other professions.

An interesting exhibit of what 100 picked men between the ages of 27 and 43 in the electrical engineering business have done was given not long ago in a paper by George A. Damon, of the Arnold Company, of Chicago, entitled, "The Opportunities in the Electrical Business," read before the electrical section of the Western Society of Engineers. Mr. Damon sent a letter of inquiry to 100 of the leading men in Chicago engaged in the various branches of the electrical industry.

The summary of the results of his inquiry was as follows:—Young men control the business. The inquiry was therefore confined to men between the ages of 27 and 45 on the theory that the older men are the product of a set of conditions that have passed away, while the youngest men are, as a rule, still engaged in a period of preparation. The 100 men are divided into groups as follows:—

	No. of Men	Average Age	Average Income
Salesmen	7	33	$2,400
Sales managers	11	36	3,400
Business men	10	36	4,800
Sales engineers	8	35	2,350
Electrical engineers	16	33	2,800
Constructing engineers	6	33	2,850
Electrical experts	8	33	3,200
Operating engineers	3	32	2,250
Operating managers and superintendents	10	34	3,550
Professors and editors	8	34	2,500
Patent attorneys	4	32	4,000
Consulting engineers	9	40	6,400

Total number of men, 100. General averages: age, 33½ years; income, $3,440.

Classified in reference to incomes, the record is as follows:—

	Men
Income over $10,000 per year	5
Income between $5,000 and $10,000	9
Income between $2,400 and $5,000	66
Income below $2,400	20
Total	100

Seventy-five per cent. of these men are college graduates. The average age of twenty men who are succeeding without a college education is 36 years, and their success measured by a monetary standard shows an income of $3670 a year. The average age of sixteen graduates of one university is also 36. Their average income is $4940, which shows a balance of $1270 a year in favour of the college education. Mr. Damon says that there are in Chicago at least 100 men whose incomes will average about the same as the first 100 selected. An effort was made to make the list representative, and the men were selected on account of their positions without reference to their incomes.

The Western Association of Electrical Inspectors

AN organization of electrical inspectors was perfected in Chicago on June 1, under the name of the Western Association of Electrical Inspectors. The territory covered by the association includes West Virginia and all the States West. The members are those connected with the Fire Underwriter Boards and the municipal electrical inspection departments in the various States.

The following officers were elected:—President, F. D. Varnam, St. Paul; first vice-president, W. B. Hubbell, Cincinnati; second vice-president, E. B. Ellicott, Chicago; secretary and treasurer, W. S. Boyd, Chicago. The executive committee consists of the officers and six others, as follows:—E. R. Townsend, Chicago; Waldemar Michaelson, Omaha; George W. Gano, Louisville; Frederick G. Dustin, Minneapolis; George D. Doyle, Chicago; Frank V. Sackett, Chicago.

The secretary, W. S. Boyd, is electrical inspector of the Electrical Bureau of the National Board of Underwriters, with offices at 382 E. Ohio street, Chicago.

Coloured electric lights were used by Rev. Father Pfaffhausen of St. Patrick's Church, St. Louis, for the recent 40-hour devotional exercises. The altar was adorned with 50 electric lights of a leafy green. The saint's statue and the altar stand in an alcove, which appeared charmingly cavernous. In order that the altar of the Blessed Virgin, on the opposite side, should not be eclipsed, 50 pale-blue electric lights were placed around it, and these gave the heavenly hue to the delicate tracing of the statue and the marble decorations. The main altar was aglow with 72 golden lights, at the top of which the crucifix was outlined in lights of red, the colour that represents the love of God.

Insulation Testing Apparatus and Methods

By C. E. SKINNER, of the Westinghouse Electric & Manufacturing Company

A Paper Presented at the Denver Meeting, Last Month, of the National Electric Light Association

AMONG the tests which are regularly made to determine the quality of a piece of electrical apparatus is that known as the disruptive or dielectric test on the insulation. Modern practice indicates the desirability of making these tests on the materials, on the parts of the apparatus, and on the completed apparatus. The users of electrical machinery frequently include such tests among those which must be made for the acceptance of the apparatus. The American Institute of Electrical Engineers has recommended a schedule to be followed in the making of dielectric tests, this schedule setting the voltage limits, but not indicating apparatus and methods.

It will be the writer's endeavour to discuss briefly the elements that should be considered in the design, selection and use of apparatus for making dielectric tests.

TESTING APPARATUS

By far the greater part of such tests are made by means of step-up transformers. The static machine may be employed to advantage in some cases, and occasional tests are made by the use of direct current such as may be obtained from an arc-light machine; but as these cases are special, they will be omitted from the discussion, and only testing apparatus employing alternating current, either direct from the generator or through step-up transformers, will be considered.

In the design and selection of apparatus for making disruptive tests, a number of points must be taken into consideration, among which are the following:—

1.—Maximum testing voltage.
2.—Frequency of testing circuit.
3.—Static capacity of apparatus to be tested.
4.—Variation of the testing voltage.
5.—Measurement of the testing voltage.
6.—Provision for locating faults.
7.—Portability of testing apparatus.
8.—Rating of testing transformers.

These items will be discussed in detail in the order given.

1.—MAXIMUM TESTING VOLTAGE

The maximum testing voltage required depends on the nature of the material or apparatus to be tested. For the lower voltage apparatus, the testing voltage is usually several times the normal rated voltage of the apparatus. For the higher voltages, the testing voltage is rarely much more than double the normal rated voltage. In testing materials, almost any voltage or any range of voltage may be required, from a few hundred volts to 100,000 or 150,000 volts. For direct-current street railway work, tests above 5000 volts are rarely required, and tests from 2000 to 2500 volts are more common on finished street railway work. Apparatus for 2000-volt lighting service requires tests of 4000 to 10,000 volts. In high-tension transmission work the test is usually from one and a half to two times the normal rated voltage of the apparatus. The highest electromotive force in use at the present time for long-distance transmission work is approximately 70,000 volts. Tests requiring double this voltage are not at all uncommon.

When the investigation of insulating materials is to be undertaken, testing apparatus giving any voltage up to 150,000 will find frequent use, and for a complete understanding of the work, occasional tests of 200,000 to 250,000 volts may be required on special insulators or combinations of insulation for the higher voltage service. Testing apparatus capable of giving half a million volts or more is merely a scientific curiosity at the present time. Tests of 100,000 to 150,000 volts will cover any commercial work, even to the most exacting line insulator tests, and 250,000 volts should be sufficient for any investigation necessary in connection with commercial work. A well equipped high-tension laboratory should have apparatus capable of giving any electromotive force from a few hundred volts to the commercial maximum mentioned.

The following table gives a list of maximum testing voltages suitable for various classes of work, together with the capacity in kilowatts which will be found sufficient for most work for each maximum voltage. Special work, such as cable testing, may require a greater transformer output, as will be discussed later.

Maximum Testing Voltage	Capacity in Kilowatts
2,000	1
6,000	3
10,000	5
30,000	30
50,000	50
100,000	100
150,000	150
250,000	250

These are arbitrary divisions that have been found convenient in practice. The ratings given are the continuous ratings based on temperature rise.

2.—FREQUENCY OF THE TESTING CIRCUIT

The frequency of the circuit on which a testing transformer is used determines in some measure its size for a given output; the lower the frequency, the larger the transformer required. A more important consideration governing the output for a given test follows from the fact that the amount of charging current to a piece of apparatus considered as a condenser varies directly as the frequency of the testing circuit. Consequently, the higher the frequency, the larger must be the testing transformer for making tests on apparatus having a given capacity in microfarads and at a given voltage. Furthermore, the dielectric loss in insulation at a stress approaching the disruptive strength also varies approximately as the frequency, requiring additional testing capacity where this feature becomes a measurable factor.

It may be stated, therefore, that for a given output, the lower the frequency, the larger the transformer required, and that for a given condition of test a larger output testing transformer will be required for high than for low frequencies.

3.—STATIC CAPACITY OF APPARATUS TO BE TESTED

Small samples of insulation require but a very small output in the testing transformer, but with large machinery or cables a much larger output is required, on account of the current necessary to charge the apparatus or cable, considered as a condenser.

The charging current varies directly

as the frequency, directly as the voltage, and directly as the static capacity; and as apparent energy is equal to current multiplied by voltage, it follows that the apparent output of the transformer required must vary directly as the frequency, directly as the square of the voltage, and directly as the static capacity (in microfarads) of the apparatus under test.

There may be slight losses in poor insulation due to current actually flowing through it, but the amount will be very small and practically negligible. The dielectric loss in the insulation is usually small as compared with the charging current, and for all practical purposes it may be left out of consideration in the design of testing transformers.

Measuring devices, such as a direct-reading type voltmeter, in series with a resistance, on very high tension circuits may take a sufficient amount of power to require consideration. For example, an ordinary alternating-current voltmeter in series with the necessary multiplying resistance on a 100,000-volt, 25-cycle circuit will require approximately 6 K. W. to operate the voltmeter at full scale deflection.

The requirement of the Committee on Standardization of the American Institute of Electrical Engineers relative to transformer output required in dielectric tests is, that "the source of alternating electromotive force should be a transformer of such size that the charging current of the apparatus as a condenser does not exceed 25 per cent. of the rated output of the transformer." This requirement seems to be based on some idea that there will be an undue rise of potential in the testing circuit unless the testing transformer output is very large. This is not borne out in practice, and it is the writer's observation, confirmed by that of others, that satisfactory tests can be made up to the full current rating of the testing transformer if the testing voltage is measured in the high-tension circuit. Modern testing transformers are as well designed as transformers for other purposes, and the American Institute of Electrical Engineers' requirement would frequently necessitate the use, especially in cable testing, of a testing transformer having an output greater than is usually available for such work.

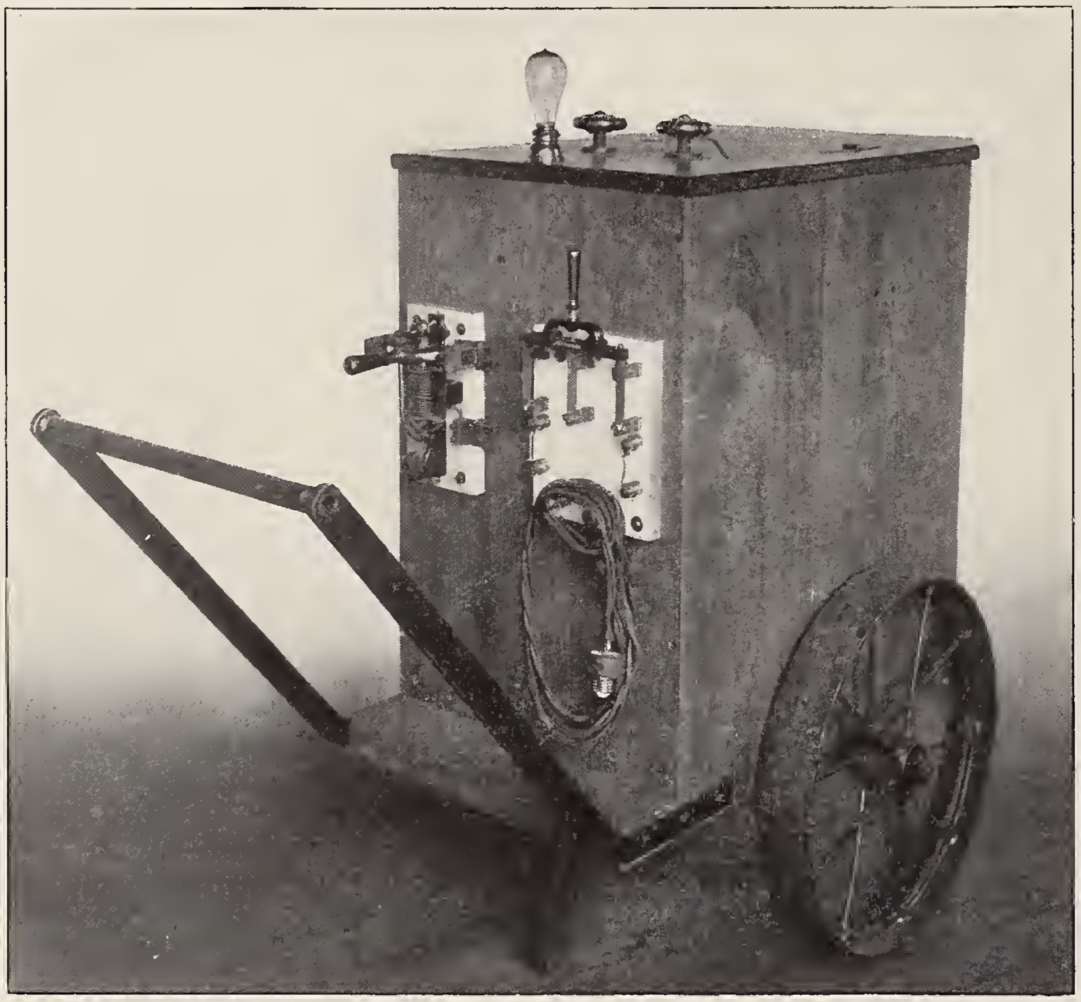

FIG. 1.—A 5-KW., 10,000-VOLT PORTABLE TESTING SET SUITABLE FOR LOW-VOLTAGE TESTING BY STEPS

As examples of the minimum capacity that could actually be used, giving full rated load to the testing transformer, the following may be cited:—

The first 5000-H. P. generators for the Niagara Falls Power Company have a capacity of approximately 0.3 microfarad, and the test voltage was 6000, and the minimum testing capacity required at the frequency of 25 cycles would therefore be 1.7 K. W. The 5000-K. W. generators of the Interborough Rapid Transit Company have a capacity of approximately 0.6 microfarad, and the test voltage was 25,000, requiring, therefore, a testing transformer of at least 50-K. W. capacity at a frequency of 25 cycles. An underground cable having a static capacity of one microfarad and tested at 20,000 volts, 60 cycles, would require a testing transformer of 150-K. W. capacity. A test at 40,000 volts on the same cable would require four times this capacity, or 600 K. W., and a test of 60,000 volts would require nine times this capacity, or 135 K. W.

4.—VARIATION OF THE TESTING VOLTAGE

There are three principal methods of varying the testing voltage when making dielectric tests. These are:

a. By varying the field of the generator. This method assumes that the generator and the testing transformer may be used as a unit. This method of variation gives a considerable range of testing voltage, depending on the design of the generator, the amount of field resistance available, and the relative amount of charging current required in the test. This variation may usually be depended upon to be from 50 per cent. of the normal rated voltage of the generator to a slight amount above the normal voltage. The variation of the testing voltage by varying the generator field is unsatisfactory when the charging current is large and the field current very low, for the reason that the charging current passing through the armature reacts on the field and causes an unsteady condition of the voltage, which is very undesirable. With this exception, the variation of the field of the generator is the most satisfactory method that can be followed, within the limits here given. This general plan is shown diagrammatically in Fig. 6.

b. By means of a resistance in series either with the primary or the secondary of the testing transformer. This method assumes that the source of supply is a constant-potential circuit. The type of resistance most frequently used consists of a water rheostat of some form, although any convenient resistance can of course be used. For small testing capacities this method is quite satisfactory, particularly if means are at hand for measuring the testing voltage in the high-tension circuit. For large capacities, the resistance becomes either very large if used in the primary, or very difficult to build and insulate if used in the secondary. Water resistance must be of such capacity that

FIG. 2.—A 25-KW. AUTO-REGULATING TRANSFORMER WITH DIAL, GIVING 5 PER CENT. STEPS

there will be comparatively little formation of gas on the resistance plates, as this formation may cause intermittent variations of the resistance and consequent undesirable variations in the testing circuit. This requires a large capacity water rheostat. The principal advantage of this method of control is its cheapness. Its disadvantages are the large size of water rheostat required, the intermittent variation of voltage apparently due to the formation of gas from the decomposition of the water, the change of the electromotive force wave to a more peaked form, and variation of the voltage due to the change of resistance as the water becomes heated and evaporates.

The general plan is shown in Fig. 7, where a water rheostat is shown in the primary circuit of the transformer, with a further variation by taps in the high tension winding. In general, the writer has found this method far less satisfactory than the one about to be described.

c. Variation by steps. A very considerable range of testing voltage may be obtained by bringing out loops from the high tension side of the testing transformer, with further combinations of the low-tension windings. This plan requires that the testing circuit be broken from step to step. Figs. 1, 8, 9 and 10 show such arrangements suitable for low-voltage testing.

Very close regulation of the testing voltage may be obtained by the use of a second transformer, which may be called a regulating transformer. The regulating transformer is connected directly to the line and has a large number of loops in its secondary winding which are connected through suitable dials to the primary of the testing transformer. This transformer may be wound with a primary and secondary, or may be of the auto type. A single dial arrangement is shown diagrammatically in Fig. 12, and a view of a 25-K. W. auto-regulating transformer with dial is given in Fig. 2. A double dial arrangement, giving still further refinement as to the gradation of the voltage, is shown diagrammatically in Fig. 13.

Fig. 3 shows a portable double dial set of 30-K. W. capacity at 30,000 volts, complete with switch, fuses, circuit breaker, choke coil for burning out faults, etc. With this arrangement it is customary to make the total range of the small step dial equal to two steps of the main dial. For quick adjustments the small step dial may be set at its middle point and the test voltage set approximately by the large step dial, final close adjustment being obtained by the small step dial. With twenty points in each dial, steps of 0.5 per cent. are obtainable over the whole range from 0 to 100 per cent. A feature of this scheme that may be objectionable in the most exacting work lies in the fact that the small dial must be returned to the zero point for each large step when changing the voltage over a wide range by small steps, or there will be a succession of small and large steps. This difficulty may be entirely overcome by the use of a third, or auxiliary, regulating transformer, as shown in Fig. 14. An inspection of this diagram shows that it is in effect the same as the double dial arrangement, with the exception that provision is made for connecting the small auxiliary regulating transformer across any consecutive pair of taps in the main regulating transformer and then varying the voltage across this pair of taps by very small gradations.

As the direction of the current is reversed in the auxiliary transformer with each large step, a continuous increase or decrease in the voltage of the testing transformer by the smallest steps without opening the circuit may be effected by moving the auxiliary dial over full range, then moving the main dial one step, then reversing the auxiliary dial over full range, etc. Twenty points on each dial give steps of one-fourth of one per cent. from 0 to 100 per cent. without opening the circuit. Fig. 4 shows a complete regulating transformer with oil-insulated dials, instruments, etc., and Fig. 5 a 200-K. W., 150,000-volt testing transformer used in connection with this regulating set.

A still further variation of the volt-

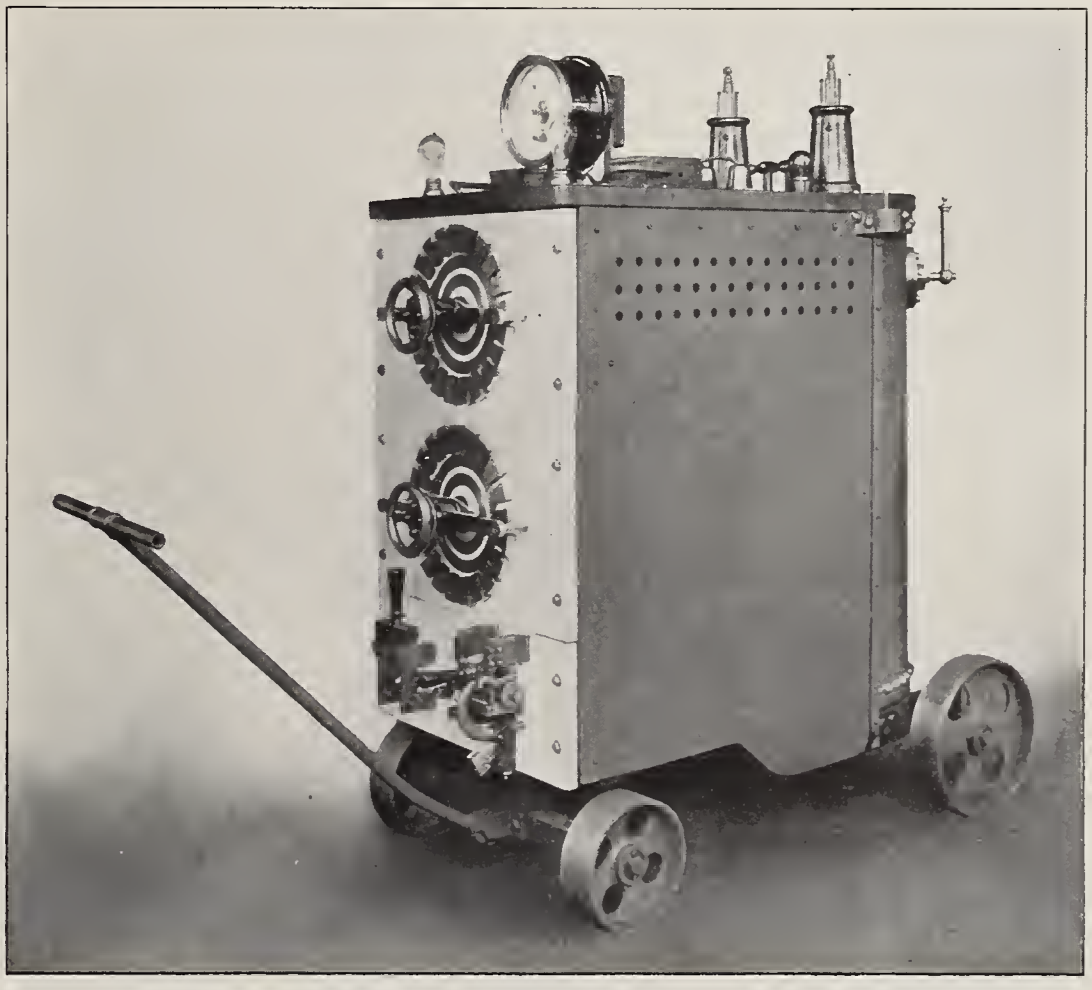

FIG. 3.—A 30-KW., 30,000-VOLT PORTABLE TESTING SET COMPLETE WITH SWITCH, FUSES, CIRCUIT BREAKER, CHOKE COIL AND DOUBLE DIALS

age may be obtained in most transformers by providing a symmetrical arrangement of the high-tension windings, which may be connected in multiple, multiple-series, or series. Four equal combinations will give three voltages at which the transformer may be used at its full rated capacity, these being 25 per cent., 50 per cent. and 100 per cent. of the maximum rated voltage.

FIG. 4.—A 200-KW. DOUBLE DIAL REGULATING OUTFIT WITH OIL-INSULATED DIALS, INSTRUMENTS, ETC., COMPLETE EXCEPT TESTING TRANSFORMER

5.—MEASUREMENT OF THE TESTING VOLTAGE

The following methods are used for measuring the testing voltage:—

a. By ratio. In the lower-voltage work, where the static capacity of the apparatus to be tested is small and extreme accuracy is not necessary, the simplest method is to measure the primary voltage and multiply by the ratio of transformation. In making a large number of tests, as is required in the manufacture of electrical apparatus, it is usually sufficient to connect the testing set to mains carrying a known difference of potential and assume that the results will be sufficiently close to the ratio. This method will be found inaccurate when the electrostatic capacity of the apparatus under test is large, a rise of the voltage in the testing circuit usually resulting when the output of the testing transformer is sufficient to carry the current without serious drop in voltage. Even when the voltage is measured directly in the testing circuit, a voltmeter in the low-tension circuit will be found a great convenience to check the readings.

b. By voltmeter readings in the high-tension circuit. The reading may be taken across the whole or only a part of the high-tension windings. Direct-reading voltmeters of the current-operated type used in series with a non-inductive resistance may be employed for this purpose. The chief advantage of this method is the ease of calibration, and it has the further advantage that the voltmeter may be an ordinary instrument supplied with the necessary series resistance. It has the disadvantages that the charging current of the voltmeter resistance may lead to inaccuracies; the voltmeter itself must be covered by a metal case which is connected to one terminal of the voltmeter to prevent the static charge from affecting the needle; and the resistance on very high voltages consumes a large amount of power; also the resistance is clumsy and difficult to insulate.

A static voltmeter in the testing circuit is theoretically the ideal method of measuring the testing voltage. Unfortunately, static voltmeters reading up to the highest voltages required in testing work are not available. Instruments of this class which the writer has been able to test are either inaccurate or are so delicate in their adjustments that they are constantly getting out of order, also the scale is short, and the range of reading is small. No thoroughly reliable instrument reading up to 100,000 volts under all conditions of service has as yet been placed on the market.

c. By spark gap in the high-tension circuit. The committee of the American Institute of Electrical Engineers appointed to consider this matter has recommended the determination of the testing voltage for any given piece of apparatus by the use of a spark gap in the high-tension circuit, this spark gap to consist of sharp needles, the distances for various voltages being given. This method has many disadvantages and few advantages. The testing voltage cannot be determined until the instant of breakdown of the gap, when the test must be discontinued. The voltage measurements are very unreliable unless especially safeguarded by an elaborate set of shields, and there is much controversy as to the actual distances which represent given voltages. When used in the testing circuit with very high voltages, the disruptive discharge caused by the breaking down of the gap may cause serious damage, either to the testing transformer or to the apparatus under test, due to the momentary rise of potential across the outer windings when the spark gap breaks down. In testing transformers and generators the spark gap should always be used in series with a very high resistance or a powerful choke coil.

d. By special voltmeter windings. In special cases, windings are placed on the transformer in such a way as to give more nearly the actual ratio of transformation than can be obtained by measuring the voltage of the primary circuit. This is really a ratio method, and is somewhat more accurate than measurements across the primary circuit, on acount of the position in which the winding is placed and the freedom from drop due to load which is experienced in the regular ratio method.

e. By voltmeter transformer. It is possible to use a step-down transformer in the high-tension circuit, connected to a voltmeter. This is a satisfactory method where the voltage is low and the output of the testing transformer sufficient to supply the voltmeter transformer losses, etc. It becomes a very expensive method with very high voltages, for the reason that the voltmeter transformer is very difficult to wind and insulate for such small capacities. For a 60,000-volt voltmeter transformer the mechanical requirements are such that

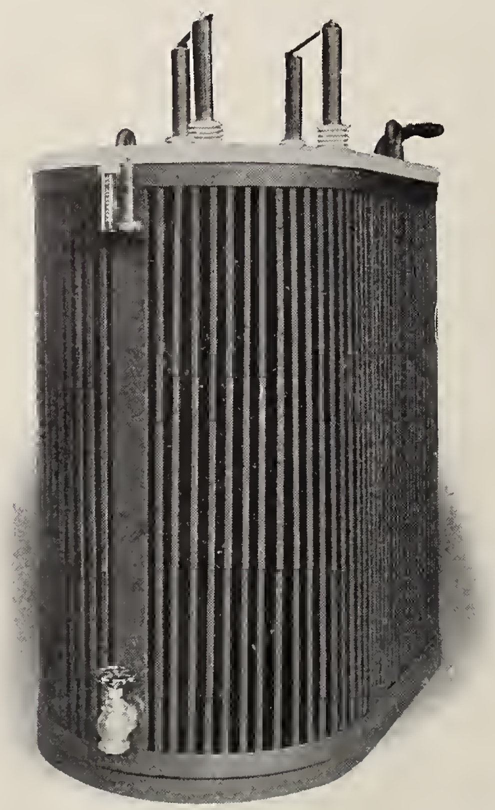

FIG. 5.—A 200-KW. 150,000-VOLT TESTING TRANSFORMER DESIGNED FOR TWO HIGH-TENSION VOLTAGES AND USED IN CONNECTION WITH THE REGULATING OUTFIT SHOWN IN FIG. 4

the transformer when built will have a capacity of 15 to 20 K. W., while the voltmeter takes only from 15 to 20 watts. The writer is familiar with voltmeter transformers where the losses in the transformer itself were many times the rated output of the transformer.

6.—PROVISION FOR LOCATING FAULTS

In many tests it is very desirable to be able to locate faults that occur under test. One of the most satisfactory methods in the testing of electrical machinery is to hold the testing current a sufficient length of time to produce burning of the insulation at the point of fault, this being located by the smoke which issues from the point. This is particularly true in the testing of windings of transformers and machines. For this purpose a resistance or inductance in some part of the circuit of the testing apparatus is very satisfactory.

A convenient method is to provide such a resistance or inductance in parallel with a fuse or circuit-breaker in the primary of the testing transformer, this fuse or circuit-breaker being so adjusted that it will carry the normal testing current until the fault occurs, the increase in current due to the breakdown blowing the fuse or circuit-breaker and thus throwing the resistance or inductance in series with the transformer. The resistance can be so adjusted that approximately normal current will flow through the high-tension windings of the transformer, and when this is done the burning may continue for any desired length of time without injury to any part of the testing apparatus. In the testing of cables it is usually necessary to burn out a breakdown sufficiently to produce a low-resistance fault, which may then be located by any of the well-known methods. The arrangement of resistance and circuit-breaker for burning out faults is indicated in several of the diagrams shown.

7.—PORTABILITY OF TESTING APPARATUS

The portability of testing apparatus is entirely a matter of convenience as required by the work to be done. In a large factory it is desirable to have apparatus giving voltages up to 10,000 or 20,000 that can be quickly moved from one point to another and can be used with the utmost despatch. For testing large machinery or insulating materials, this portability is not so essential, as the tests are fewer with more time available, or the material may be brought to the testing apparatus. For an ordinary power plant it is generally sufficient to have a stationary testing outfit, which may be wired to convenient points in the building. For heavy road work a semi-portable outfit for the higher tension work is desirable, so arranged that it can be shifted from place to place. The portability depends on the size and general construction of the apparatus. The type shown in Fig. 3, which gives extreme flexibility as to variation of voltage, variation in the primary source of supply, etc., can be made without difficulty in portable form up to 30-K. W. capacity.

8.—RATING OF TESTING TRANSFORMERS

Throughout this paper the kilowatt rating of testing transformers has been referred to, and wherever used this refers to the usual method of rating based on rise of temperature when the transformer is carrying the rated load continuously. As a matter of fact, testing transformers are rarely, if ever, used continuously, and usually tests are made only for a very short length of time. The requirement of the American Institute of Electrical Engineers is that the test shall be continued for one minute. As most transformers will carry for short periods several times the amount of current allowable for continuous work, it is obvious that the continuous rating is not a satisfactory basis for testing transformers.

When a testing transformer is to be used for routine cable testing, where the tests are applied for some length of time with but short intervals between tests, the rating may properly be made on the time temperature basis. For nearly all other work the rating can be on the basis of the maximum current that the transformer can deliver for short periods of time. It should be apparent that each class of work will require a special rating, and that there will be wide differences between the different classes.

TESTING METHODS

In the testing of materials, the very greatest variety of physical characteristics will be met with,—as fabrics, porcelain, oil, papers, and almost every conceivable combination of materials. So diverse are the kinds that only general rules can be laid down covering the methods to be followed.

To insure uniformity of results (and the best results rarely agree closely) tests on similar products should of course always be made in the same manner, and it is always desirable to check tests on new materials with results of tests on materials of the same class whose qualities are known, the check tests being made at the same time and under the same conditions. The contact terminals should be of the same size and shape. The rate of application of the voltage and the total time of making the test should be the same. The method of measurement should be the same. The constants of the testing circuit,—frequency, wave form, etc., should always be the same for comparative purposes.

For sheet material, metal terminals with the edges well rounded, to prevent concentration of electrostatic flux at the sharp edges, should be used. When the sheets are small and the test voltage low, circular terminals with an area of approximately one square inch, with edges rounded to a 0.25-inch radius tangent to the testing surface, will give good results. Many tests are made between terminals having spherical contacts, 0.5-inch to one-inch hemispheres turned on the ends of rods being employed. For irregular shaped solids, such as porcelain, the conditions of service should be simulated as far as possible. For example, a line insulator should have a contact similar to that of the line and tie wires, and test should be made to a metal pin, under the assumption that the pin is wet and therefore a conductor; or test may be made by inverting the insulator in a salt-water bath and filling the pin hole with the same solution. For liquids, the oil-testing device described in a paper by the writer on "Oil for Insulating Purposes," read before this association last year, will be found satisfactory.

High temperatures may be produced in insulating material by the I^2R losses when the material has low insulation resistance. In materials such as marble and slate, which may have low insulation resistance due to moisture, the heat caused by the I^2R losses may dry the material to such an extent that the insulating quality is increased as the test proceeds. With fibrous materials the reverse is usually true, as carbonization takes place before the drying-out process is complete.

In testing solids the effect of heat due to dielectric losses is an important factor in the results, particularly when large contacts are used and tests are long continued. For a fuller discussion of this point, see paper by the writer, entitled "Energy Loss in Commercial Insulating Materials When Subjected to High Potential Stress," in the Proceedings of the American Institute of Electrical Engineers, Vol. 19. The heat generated weakens the insulation, and breakdown results at a lower voltage than when the time occupied in making the test is short. This will be found

particularly true of materials like glass, treated cloth, mica, etc. Most insulating materials in the solid form decrease in insulation strength as the temperature is raised, and therefore the temperature at which tests are made should be held as nearly the same for different tests as possible.

Aside from the heating effects just noted, the method of applying the voltage when testing samples of material is not of much importance, whether by steps, by gradual rise, or by the application of full voltage at once, where the test is a predetermined amount and the testing voltage not high,—say not over 20,000 or 25,000 volts. It is important, for purposes of comparison, that the same method be used for different samples of material of the same general class. As the actual breaking-down point is desired in most tests on material, the voltage must be applied in predetermined steps, or the rate of increase must be such that voltmeter readings can be taken and the exact point of breakdown determined. For low-voltage tests the step-by-step method, keeping the primary voltage constant and determining the test voltage by ratio, is recommended for rapid work. For higher voltages, say above 20,000 or 25,000, the slow increase of voltage, either by steps without opening the circuit or by smooth increments, as by control of the alternator field, gives better results. The voltage may be read by ratio, or by a static or direct-reading voltmeter in the high-tension circuit. No single test should be taken as an index of the dielectric strength of any material, but the average and lowest of many tests should be considered.

In the testing of dynamos, motors, transformers, cables, etc., the static capacity of the apparatus under test becomes of more importance, especially with the higher voltage tests, requiring larger testing apparatus and greater care in the application of the testing voltage. There will also be greater tendency to variation in the testing circuit due to rise of potential on large static capacity, drop due to overload transformers, etc., than with samples of material, hence the ratio method of measuring the voltage is less satisfactory than in material testing.

Furthermore, tests on finished apparatus are usually not made to determine the ultimate breaking-down strength, but to determine whether or not the insulation as a whole will stand a certain predetermined test, allowing a factor of safety over the working voltage, just as a boiler is tested with a certain excess pressure for the same reason. It is good prac-

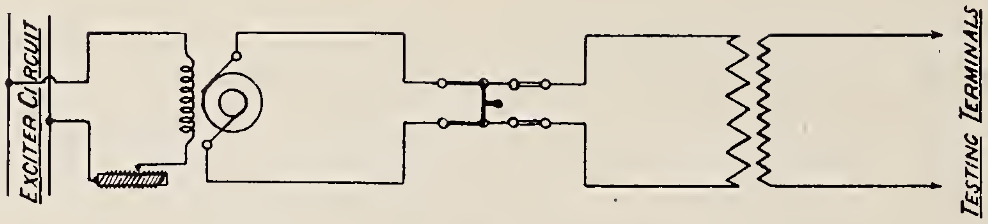

FIG. 6

Voltage regulation by field rheostat of generator. Range of testing voltage, from 50 per cent below to 25 per cent above normal rated voltage of generator, or from approximately 25 per cent to 100 per cent of the maximum voltage of the testing transformer. Suitable for all classes of work and for all capacities of testing transformers.

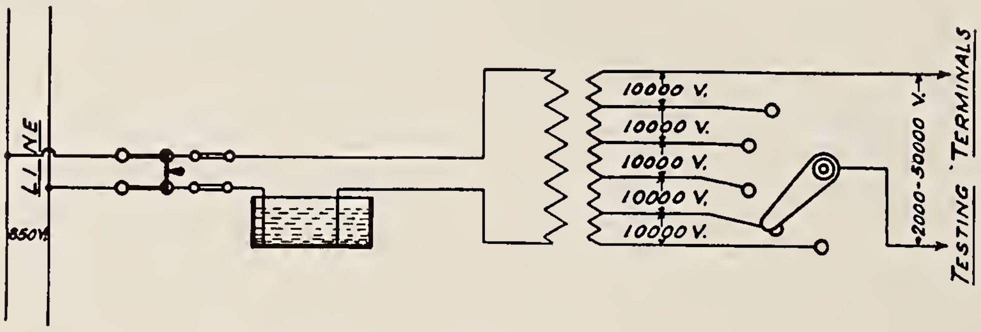

FIG. 7

Voltage regulation by means of water rheostat in series with low-tension winding. Range of variation, from approximately 25 per cent to 100 per cent of the maximum voltage of testing transformer. Suitable for general use, with exceptions noted in text. This diagram shows a further variation of the voltage by means of taps brought out from the high-tension winding of the testing transformer.

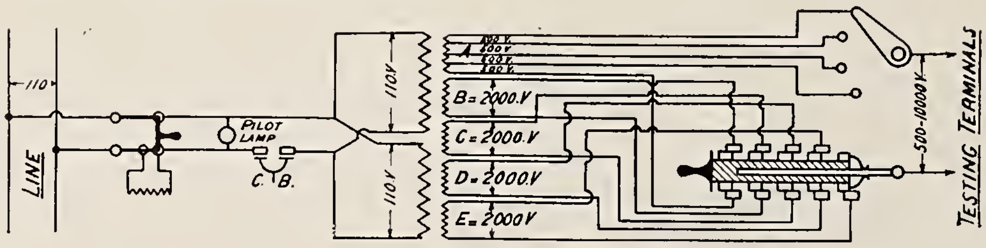

FIG. 8

Voltage regulation by steps in testing circuit. Circuit must be opened between steps. Coils not in use disconnected from testing circuit by special plug switch. Resistance in primary through which circuit is closed to prevent surges. Suitable for general low voltage testing.

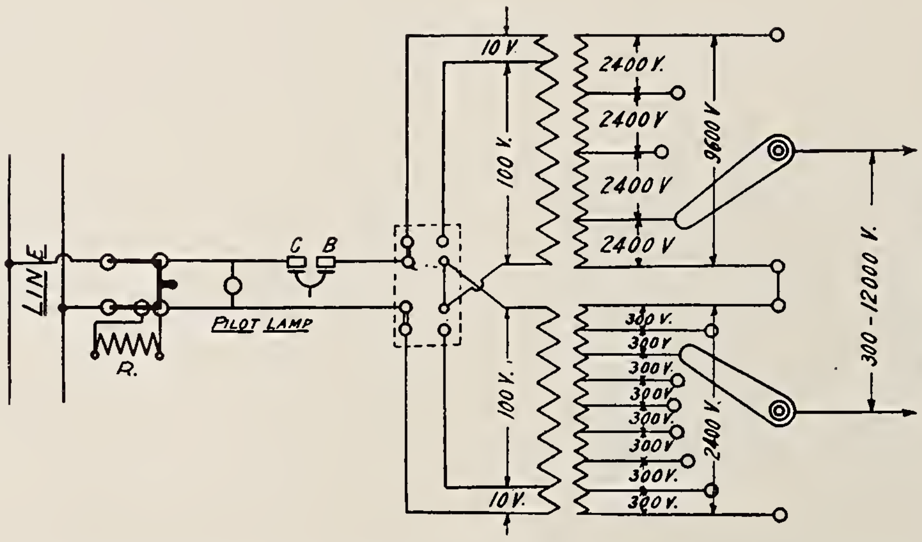

FIG. 9

Voltage regulation by steps in testing circuit. Circuit must be opened in passing from one step to another. Primary suitable for 100, 210 or 220-volt circuit. Range of voltage, from 2.5 per cent of normal to normal voltage, by steps of 2.5 per cent. Suitable for general low voltage testing.

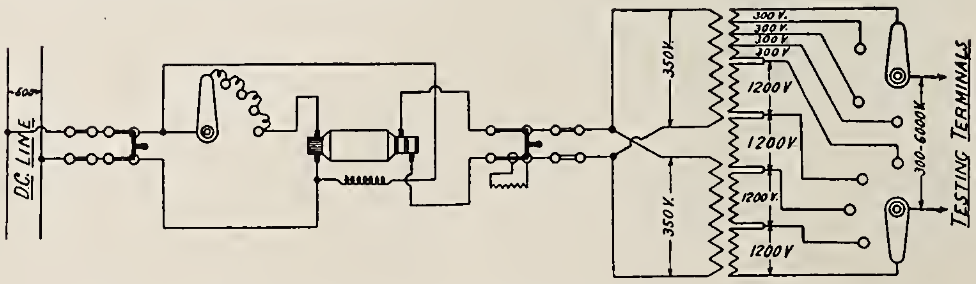

FIG. 10

Direct-current to alternating-current testing set. Direct-current to alternating-current or inverted rotary used to transform 500-volt direct current to 350-volt alternating. Voltage regulation by series resistance in direct-current circuit and by steps in testing circuit. Testing circuit must be opened between steps. Suitable only for small sizes and comparatively low voltage work.

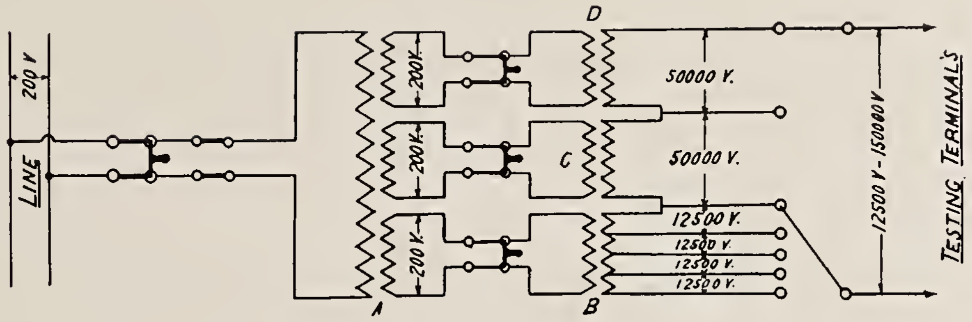

FIG. 11

Voltage regulation by steps in testing circuit. Testing transformer in series with insulating transformer in primary to add insulation to system. Output may be increased on the lower voltages by connecting high-tension windings in multiple. Suitable for use with transformers whose individual insulation is not sufficient for the final testing voltage. Insulating transformer requires high insulation between all coils.

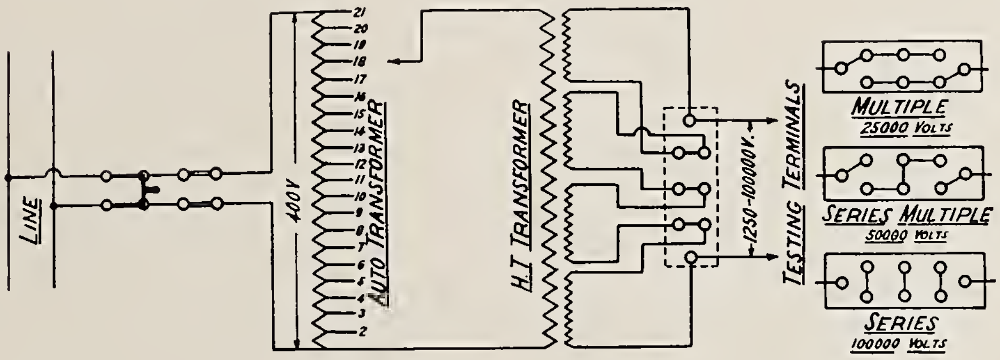

FIG. 12

Voltage regulation by regulating transformer and dial, also by combinations of coils in high tension winding. Range, 5 per cent steps from 5 per cent to 100 per cent of normal voltage without opening the circuit. Suitable for all classes of work and with testing transformers up to 25-kw. or 30-kw. capacity.

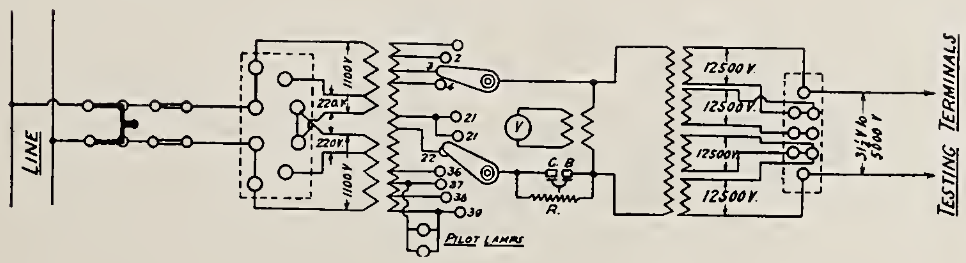

FIG. 13

Voltage regulation by regulating transformer and by combinations of coils in high tension windings. Two dials, arranged, one to give 0.5 per cent steps and the other 5 per cent steps without opening the circuit. Intermediate circuit may be grounded for safety to operator. Suitable for all voltages and all capacities up to 200 kilowatts.

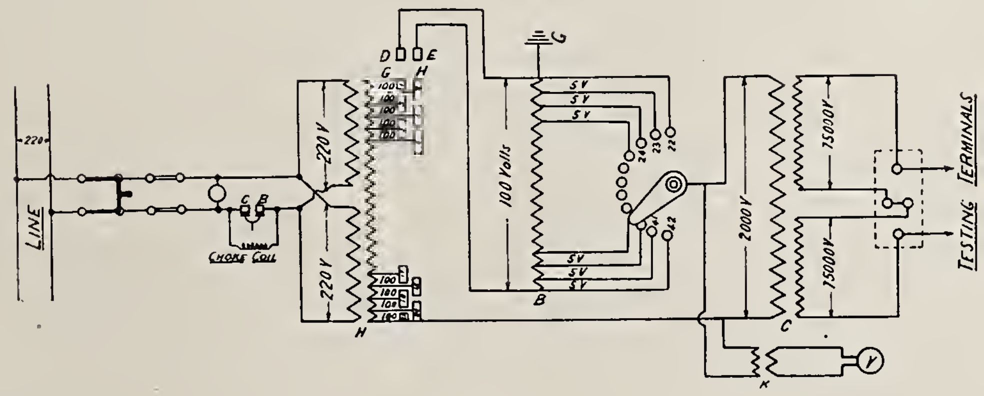

FIG. 14

Voltage regulation by regulating and auxiliary regulating transformers, with double dial. Range, steps of .025 per cent from 0.25 per cent to 100 per cent without opening the circuit. Full equipment of instruments, means for locating faults, etc. This makes an outfit suitable for universal application for sizes up to 250 kilowatts and for any maximum voltage which may be required.

tice in manufacturing work to test each part as it is finished, as well as the completed apparatus, in order that any defective workmanship or material may be discovered before the parts are finally assembled. The user of the apparatus is concerned only with the dielectric strength of the apparatus as a whole, while the manufacturer is concerned with each individual part as well as the completed product. It is customary in manufacturing work to find the ultimate break-down strength for each class or type of apparatus, by actual break-down tests on individual pieces, this showing the weakest point and the necessity for any change in material or design if the ultimate strength is not sufficiently high.

In testing electrical machinery during the course of manufacture it is customary to grade the tests from higher to lower values as the apparatus nears completion. By this method any given test is lower than the preceding, and small variations in the voltage of the line supplying the testing circuit will not cause any difficulty.

Transformers are sometimes tested by their own voltage, this giving a plan different from any of those previously described and requiring no testing transformer. In such tests, one side of the high-tension winding is connected to the low tension and the iron, and then the transformer operated at a potential sufficiently above the normal to give the necessary test voltage. The other side of the high-tension winding is then connected in the same way, and the test repeated. Attention should be called to the fact that in this test the middle part of the winding receives but half the total test voltage to ground and low-tension coils, there being a uniform grading of test voltage along the winding from the middle point to the outer ends.

In making dielectric tests on completed apparatus, the condition of the apparatus at the time of test is a point which should always be considered with reference to the test. Insulation resistance measurements usually give some indication of the condition of the apparatus with reference to dirt and moisture. A high insulation resistance test, however, does not necessarily indicate that the dielectric strength will be high, but a low insulation resistance test usually indicates a low dielectric test, particularly if the dielectric test is long continued.

Long continued tests on apparatus such as dynamos and motors are considered very inadvisable, unless the voltage of test is very much below the

ultimate breaking-down strength, and the condition of the apparatus with respect to moisture is perfect, as such long continued tests are liable to produce incipient burning at points within the insulation, which may not be discovered by the test.

In the making of insulation tests of all kinds the factor of personal danger should always be considered. The lowest maximum voltage previously given in the table of testing apparatus in this paper is considerably more than is necessary to cause death. Special care should be taken to protect not only the operator, but others in the neighbourhood of the apparatus under test. If it is necessary to handle the live terminals at all, only one should be handled at one time, and it should be insulated beyond any possibility of breaking down. The low-tension circuit and the case of the testing set should be grounded whenever possible. Where a regulating transformer is used, the intermediate circuit should always be grounded, as well as the frame and case of the transformer. As this circuit is entirely independent of both the source of supply and the testing circuit, it can be grounded without affecting either. For this reason the regulating transformer with primary and secondary is preferable to the auto or single coil transformer, although the latter is cheaper for a given output. A very excellent safeguard for the operator is effected by the use of a main switch which is automatically opened and held open by a spring. With this device the operator must hold the switch closed as long as the test is continued.

The necessity for these precautions is so obvious that it would seem hardly necessary to call attention to them here, but the writer has noted the indifference and carelessness customary with those who habitually handle testing apparatus of this class, and it is the purpose of this paragraph to warn such that it is hardly possible for the same individual to make more than one mistake.

Figs. 6 to 14, inclusive, show a few of the combinations of generators, testing transformers, regulating transformers, etc., which may be made for testing purposes. These diagrams have been drawn to show fundamental principles rather than actual details, but they are all based on testing apparatus which is in actual use. The general characteristics of each class are outlined in the caption that accompanies each diagram. Attention is called to the fact that many of the minor details, such as preventive resistances, for the dials, voltmeter connections, etc., have been omitted for the sake of simplicity. Where fuses are shown between the main switch and the testing transformer these are considered a part of the testing set, and are used in addition to the main cut-outs which are usually supplied to any branch line, these cut-outs not being shown in the cuts.

Arc Headlights for Locomotives

By GEORGE L. CLARK

ARC headlights for locomotive service have been in use for several years, but the results obtained with them have not been as widely appreciated as is desirable. At the recent Railway Appliance Exhibition at Washington, held in connection with the International Railway Congress, the attention of visitors was strikingly draw to the subject by the Pyle National Electric Headlight Company, of Chicago, which exhibited a full-sized locomotive equipment on the grounds near the Washington Monument. During the evening hours the headlight equipment was in regular operation, current being supplied from the adjacent plant of the Potomac Electric Light & Power Company. The headlight dynamo was driven by an electric motor on account of the absence of an available steam supply for the operation of the direct-connected turbine which constitutes the prime mover of the set. The rays of the headlight were thrown upon the top of the monument, 555 feet above ground, and the resulting illumination was visible from all parts of the city and its immediate suburbs.

The arc headlight equipment ordinarily furnished for locomotive use consists of a compound steam turbine, direct coupled to a double-pole, direct-current, 35-volt generator, an arc lamp with a parabolic reflector and material for three incandescent lights in the cab for gauge illumination. The steam turbine has no wearing surface requiring lubrication, so that no sight feed lubricator is required in the cab. The generating set is, naturally, extremely compact, and it has a capacity of approximately 1 K. W. It is usually mounted on the top of the locomotive boiler, either in front of the stack and directly behind the headlight proper, or else just in front of the cab and behind the steam dome and whistle. Steam at full boiler pressure is supplied through a $\frac{3}{4}$-inch pipe to the turbine, the valve for control being mounted in the cab at the highest part of the boiler, as dry steam is imperative. The turbo-generator requires a base of only 18 inches, and its width is equal to the standard for oil headlights. The exhaust steam is discharged through a $1\frac{1}{2}$-inch pipe, nearly flush with the nozzle tips of the locomotive.

In view of the tremendous jarring and vibration sustained by the modern heavy locomotive at high speed, even when running on first-class roadbed and track, the construction of electric headlight apparatus is necessarily rugged beyond ordinary practice. The wires are run in wooden bushings and the commutator is specially designed to withstand the shocks of high-speed service. The use of boiler pressures of 175 to 200 pounds per square inch in the turbine involves more than ordinary skill in substantial designing.

The carbons used in the light are $\frac{5}{8}$-inch in diameter and 12 inches long. When steadily burned they last about 9 hours. The current required is 23 amperes and the cost of operation generally varies from about 75 cents to $1.50 and upwards a month for one locomotive. The normal speed of the turbine is about 1800 revolutions per minute, and the lamp can be moved in all directions for focusing. The approximate first cost of a single locomotive equipment is, in round numbers, $220 installed, or about $1\frac{1}{3}$ per cent. of the total cost of a modern high-powered locomotive. Experience with the first equipments placed in service has shown that a carbon brush for the under side of the commutator and a graphite brush for the upper side give best results.

As is generally appreciated, the economy of the arc headlight lies in its great generation and searchlight effects, preventing collisions or derailments caused by obstacles which, with the ordinary types of oil headlight, are seen too late to avoid danger. It is peculiarly adapted to service on prairies or other rolling country, and the saving in damage claims for cattle struck by locomotives is often very considerable. One road reduced its claims from 150 to 35 a month by the use of arc headlights on only 40 per cent. of its locomotives, and, in another case, a road located in the cotton belt of the South reduced its cattle claims from $1000

a month to practically nothing. The point is that cattle, seeing the approaching arc headlight, will not stampede to the track, as they often will in the presence of the less penetrating oil lamp.

Although much has been said in the newspapers about the practice of deflecting arc headlight rays vertically or at an oblique angle into the sky, there is little advantage in such a use of the equipment. What is wanted is that the light shall strike an approaching engineer squarely in the eyes at a sufficient distance to insure stopping his train before an accident can occur. If the rays are thrown upon the sky there is a good chance of their being lost or undiscovered as soon as is desirable. The penetration of the modern arc headlight is so powerful that it is frequently possible to pick up a pin ¼ mile from the locomotive.

It is sometimes urged that an arc headlight should be operated from the baggage car generating set, in case such an outfit is used for electric train lighting. This would be simple enough, were it not for the frequent disconnection of the locomotive from the train at terminals or junction points, when the locomotive would be without a headlight. In view of the small cost of equipping locomotives with a self-contained outfit, it is a question if the methods outlined above do not give the best results, generally speaking. In some cases the under side of the locomotive has been equipped with small incandescent lamps, which are turned on by the engineer in coming to a stop at the stations, largely as an advertisement, but still effective in permitting rapid inspection of the running gear without the usual greasy and flaring oil torch. It is a question how much real value attaches to this sort of a display, however.

Arc headlights are successfully used in Japan, Australia, South America and other countries besides the United States. Sometimes it is claimed that their brilliancy is disconcerting to yardmen, but there is no reason why a simple translucent screen cannot be attached to the lamp in such cases and arranged to be operated from the cab. Again, it is claimed in some circles that arc headlights are unreliable and that they are prone to go out at critical times when in service. In such cases it is almost certain that proper care has not been given to the equipment; if it is given a little attention each day, it is exceedingly reliable, but that attention must be intelligently applied.

The mica between the copper strips of the commutator should always be slightly below the surface; if it gets too low it is liable to collect dirt and cause a short circuit. At the end of each trip the commutator should be cleaned with a damp, but not wet, piece of waste, the rubbing being done endwise, so as to keep the spaces clean where the mica is filed out. The brush spring tension must be tight enough to prevent sparking, but not tight enough to create needless friction and wear. The commutator is the most vital part of the dynamo, and it requires regular and careful inspection. In some of the later equipments the top and bottom brushes are of the same quality.

The long list of terrible accidents which makes up the casualty record each year on American railroads requires that every reasonable and financially possible precaution be taken to prevent such occurrences. Figures are not available at this time showing the part which arc headlights have played in the narrow escapes of railroad operation; but there is little doubt that here, as in automatic signaling and manual communication, electricity is proving to be the frequent salvation of both lives and property.

Electric Irrigating Pumps in Egypt

According to the Bulletin of the French Chamber of Commerce, agriculture and irrigation are the principal operations carried on in Egypt, and it is in irrigation that electricity is most likely to be of service. For this purpose large numbers of small pumps are now used, which could frequently be replaced by a smaller number of electrically-driven pumps. These could be supplied with energy by means of overhead wires carried a considerable distance to the source of power. The report considers that in Upper Egypt this application of electricity will be found most useful, and that the falls of the Nile should be used as a source of power. Information is also given as to the extent to which electricity is now used in the larger Egyptian towns, and in factories which have sprung up in the neighbourhood. For electrical purposes it is said that the oil engine is a strong competitor with electricity in certain districts, owing to the cheapness of oil.

A new electric cash register is among the novelties to which electricity has been applied. It is claimed that this new invention gives quick and accurate service.

Electrical Time-Savers in a Manufacturing Plant

Before the installation of an electric traveling crane at the works of the Chapman Valve Manufacturing Company, it required a yard gang of ten men, no end of skids, blocking, tackle and a pair of horses nearly one day to load two 48-inch valves, at an expense of about $20. After the introduction of the traveling crane another test was made on two 48-inch valves; the loading was accomplished in twelve minutes with three men and a current consumption of less than 3 cents worth.

Another time-saving feature is a number of 1-inch whistles, with solenoid magnets attached, distributed throughout the plant and connected to the lighting circuit. Should a long distance call come in for the manager or superintendent and the operator could not reach him at his office, she would, by pressing a button on the switchboard the required number of times blow his telephone number on all the whistles in the plant, and the man wanted would step to the nearest 'phone and immediately get in touch with his party without loss of time. These whistles are also used as signals by the superintendent for calling some heads of departments should he want them in a hurry, and in connection with the large steam whistle morning, noon and night.

The use of electricity for power on Tyneside, England, according to Lord Armstrong in a presidential address last January before the North-East Coast Institution of Engineers and Shipbuilders, has increased by some 2000 per cent. in the last five years, works employing nearly 40,000 men being now operated electrically, and altogether close on 50,000 H. P. of steam machinery has been displaced. More electricity is sold for power purposes per head of population on the north bank of the Tyne than in any other town or district in the world. The major portion of this electricity is derived from generators and from turbines built on the Tyne by C. A. Parsons, and the whole of this development has occurred within five years.

Recent figures show Germany's mineral production for 1904 to be in part as follows:—Iron ore, 22,047,297 metric tons; zinc ore, 715,732 metric tons; lead ore, 164,440 metric tons; copper ore, 798,214 metric tons. A metric ton is one of 2204.6 pounds avoirdupois.

THE ELECTRICAL AGE

Volume XXXV Number 1
$2.50 a year ; 25 cents a copy

New York, July, 1905

The Electrical Age Co.
New York and London

ESTABLISHED 1883

Published monthly at 3, 5 and 7 W. 29th Street, New York City.
Telephone No. 1617 and 1618 Madison Square. Private branch exchange connecting all departments. Cable Address—Revolvable, New York.

SUBSCRIPTION RATES

The Electrical Age will be sent post free anywhere in the United States and its possessions, Canada and Mexico for $2.50 per year, single copies 25 cents. To Great Britain and all countries embraced in the postal union, $5.00, 20 shillings, 25 francs, 20 marks, or 15 rupees. Send subscriptions to our nearest branch office or agency.

NOTICE TO ADVERTISERS

Insertion of new advertisements or changes of copy cannot be guaranteed for the following issue if received later than the 15th of each month.

LONDON OFFICES

Business Department, 33, Bedford Street. Editorial Department, 22, Henrietta Street. Covent Garden, Strand, W. C.

London Telephone, Post Office, 3807 Central. Private branch exchange. London Cable Address—Revolvable, London.
All remittances to London Office should be crossed London and County Banking Company.

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Leading Articles

Some Points in Window Lighting

To the central station manager anxious to improve his load factor, the lighting of shop windows offers an attractive field. In many cities the advantages of selling current for advertising purposes have long been appreciated, both from the standpoint of the merchant and the electric light company. One cannot travel about the country extensively, however, without realizing that in numerous cases, particularly in the smaller towns, the quality and quantity of window illumination is not all that good practice requires.

A dismal business street, inadequately lighted at night, repels about as many pleasure seekers and strollers in search of healthful recreation as a brightly lighted thoroughfare attracts. Experience shows that when merchants illuminate their store windows during the early hours of evening, after business has ceased, the display has a real advertising value, while the central station man is frequently able to offer lower rates than at other periods of the day, because of the equipment in his plant which might otherwise stand idle. The problem of shutting off the lights at midnight, or earlier if desirable, is easily solved by the installation of an automatic time switch, which can either be sold outright to customers or rented for a small yearly sum.

The exact installation of lamps necessary to properly illuminate a store window is naturally a problem to be determined by such local conditions as the size of the window, the character of goods displayed, the colour of the walls, ceiling and bottom of the casing, the cost of installation and prices charged for current. In general, it is better to install a few lamps, well placed, than to bunch the illumination in groups of the same aggregate number of candle-power. In the majority of windows a dozen 16-candle-power lamps can be made to give a most satisfactory illumination, provided they are well distributed over the window area. A soft, clear, and often brilliant, lighting of the exhibit space is what is wanted, although in some cases arc lamps seem to fill the requirements to the satisfaction of the consumer.

It must not be forgotten in this sort of work that the lighting installation is the means and not the end of the window display. For this reason it is good practice to make the lamps as inconspicuous as possible, placing them out of the natural line of sight of the passers-by, and sometimes concealing them entirely from view. The scheme of bordering the window with lamps even as small as 2 or 4 candle-power is open to considerable objection on account of the distraction which it is liable to produce in the observer's attention. A haberdasher, for instance, is not in business for the purpose of exhibiting a neat row of miniature lamps, although in several towns various shopkeepers attracted much attention in the earlier days of the mercury vapour lamp by a skilful display of it as a novelty in their show window.

The fundamental point is to distribute and subdivide until the window approximates the ideal of sunlight illumination. The same conditions which enabled the incandescent lamp to be used with such signal success last year at the St. Louis Exposition apply on a smaller scale to the most effective types of window illumination. It does not seem to make so much difference what kind of bulb, shades or reflectors are employed, provided the lamps are installed high enough up and sufficiently far apart to throw a flood of light downward upon the goods displayed, but in cases where lights are installed around the borders of the window, reflectors should invariably form a part of the equipment, otherwise a large portion of the illumination will be wasted. Large mirrors at the background are often very helpful.

A point worth bearing in mind by the central station man is the ease with which comparisons can be made between different schemes of window lighting. It is only necessary to conduct the prospective customer to a point where, for example, he can personally observe the contrast between two adjacent establishments—the one reflecting the ghastly greenish glare of the worn-out Welsbach

burner, the other illuminated with the steady, clear, and artistically diffused glow of the electric lamp. There is not enough margin between the relative cost of electricity and gas to turn the scale in favour of the latter if the best results for the money expended are to be secured.

The American Institute of Electrical Engineers

THE able address of President J. W. Lieb, Jr., at the Asheville convention last month of the American Institute of Electrical Engineers, has received wide and possibly some unexpected attention. The address is confined to matters relating to the conduct of the Institute and of comparisons with other engineering societies "not with a view of criticising the methods followed or results accomplished by our sister societies," as Mr. Lieb said, "but for the purpose of profiting by their experience, and, if possible, avoiding in our own rapidly growing body any abnormal development which may detract from its efficiency as a whole, or result in purely local development at the sacrifice of general usefulness and national standing."

The first question discussed by President Lieb is that of the grades of membership of the Institute, together with the requirements of admission to those grades and the method of election to them. The present method of election to associate membership of the Institute is by formal application for membership. The application is referred to the board of examiners whose report is forwarded to the board of directors of the Institute for election or rejection as the case may be. Any reputable person interested in electricity is eligible to admission to the grade of associate in the Institute.

Full membership in the Institute is effected by transfer from the associate grade. The qualifications required by the constitution for this grade are clearly defined and require that the applicant shall have been an associate, shall be not less than twenty-seven years of age, shall have been in the active practice of his profession for five years, during two years of which he shall have been in responsible charge of work, and that he shall be qualified to design as well as to direct electrical engineering work. A professor of electrical engineering in responsible charge of an electrical engineering course for two years, or any one who has done important original work of recognized value to electrical science, is also eligible to transfer to the grade of full membership.

President Lieb pointed out that the more explicit the constitution in its exact definition of the qualifications required for membership, the easier it would appear to be to pass upon these qualifications, but this, he intimated, is not always the case, as it often prevents the taking of a broad view of the candidate's general attainments, and is liable to exclude desirable material on very technical grounds. On the other hand, these hard-and-fast requirements are a protection against loose interpretation of the requirements by careless examiners.

Mr. Lieb implied that in his view the qualifications for transfer to full membership in the Institute are somewhat rigorous for a young society covering a branch of engineering that has but recently become specialized.

"Under the Institute's constitution" he said, "however eminent a man may be as a civil, mechanical, or mining engineer, he may not fulfil the qualifications of an electrical engineer."

This statement is virtually accurate as it relates to a civil or mining engineer, but so closely related is mechanical to electrical engineering that it would not appear to be difficult for any mechanical engineer of wide experience to pass the qualifications of the Institute,—indeed an examination of the list of members of the Institute will readily confirm the latter view.

It is quite natural and fitting that the American Society of Civil Engineers, which claims to embrace all engineers, should admit to its membership men of attainment in all branches of engineering, but it is a little difficult to perceive why a society specifically organized for "the advancement of the theory and practice of electrical engineering and of the arts and sciences connected with the production and utilization of electricity, and the maintenance of a high professional standing among its members" should be blamed or criticized if purposely its constitution makes it difficult for engineers who are not electrical engineers to obtain admission to its membership.

The present constitution of the Institute was adopted on May 21, 1901. Prior thereto, membership was open to "electrical experts, electricians, or electrical engineers possessing such knowledge of the principles of electrical science and such familiarity with the practical applications of electricity in its several branches as those branches imply." Hence it is evident that the existing qualifications for membership were drawn for the express purpose of restricting the membership to electrical engineers of ability and experience. The high and growing respect in which membership in the Institute is held would therefore seem to indicate that the present requirements are not operating detrimentally to the best interests of the Institute. President Lieb's suggestion that a place be provided in the Institute for men of high attainments in other branches of engineering, however, merits careful consideration.

But it is not easy to see just how this suggestion is to be successfully carried out, inasmuch as any amendment to the constitution requires an affirmative vote of a majority of the qualified members and associates of the Institute. With such widely scattered membership as exists in the case of the Institute and the proverbial proneness of the average individual to neglect or postpone action in such matters, the ready ability to obtain a majority vote on this or any other matter may reasonably be questioned.

Another important matter which President Lieb discussed is that of the method of nomination and election of the officers of the different engineering societies. A truly national society, he pointed out, should draw its membership from all parts of the country, and should select its officers and managers, consistently with the practical conduct of the Institute, from different sections of the country. It is, of course, self-evident that a majority of the officers, managers, and members of the various committees must be selected from a circumscribed territory in order that regular meetings may be held. Men must also be selected who have the time, the inclination, and the ability to properly serve in the various capacities.

In the case of the vice-presidents of the Institute the constitution provides that the board of directors shall select as their nominees for election the names of members with due regard to a geographical distribution of these offices. Since the publication of President Lieb's address, some adverse criticism has been published relative to the failure of the board of directors to comply with this requirement of the constitution, the result being apparently that an undue share of the offices of the Institute have gone to its New York members. Possibly this criticism is deserved. In fact, one might go farther and say that an examination of the list of officers for the past eight or ten years would tend to show that the board of directors is in some danger

of becoming a self-perpetuating body, so commonly does the transition of certain members from manager to vice-president, or the reverse, occur Some criticism has also been heard concerning the fact that in certain cases the management has not impartially selected the names of members who have received the highest number of votes on the preliminary balloting. There is, however, no question that the affairs in general of the Institute have been wisely, efficiently, and economically managed. This fact is abundantly demonstrated by the comparative figures given in President Lieb's address.

The statement, too, has been made that the benefits in the way of meetings and papers also have favoured the New York members. However true this statement may have been in the early days of the Institute, there is now no cause for such a claim or for any discontent on the part of members in any section of the country on that account. In point of fact, the Institute has led the way among engineering societies in initiating local organizations or branch meetings of the Institute in many parts of the country at which the papers presented to the Institute are read and discussed. In the language of President Lieb, "these organizations have done much to keep up the interest at distant points, and they have undoubtedly induced desirable accessions to the membership and have been an important stimulant to professional activity."

President Lieb and the Institute are certainly to be congratulated on the excellent standing of the Institute among other engineering societies which his address discloses, as well as for the harmony of thought and action that prevail among its members on all matters that relate to the best interests of the Institute.

Protecting Underground Cables Against Burn-Outs

At a recent meeting of the American Institute of Electrical Engineers, in a discussion of the papers on the protection of central stations from interrupted service, attention was drawn to the fact, which the speaker stated had been experimentally verified, that the higher the electromotive force in underground cables, the less the damage likely to be caused to adjoining cables; in other words, the heavier the current, the greater is the danger to neighbouring cables; in fact, the damage will be proportional to the square of the current. We have no desire to gainsay this statement, but it might be pointed out that if the electrical energy let loose in one cable be sufficient to set fire to neighbouring cables, and put them out of business temporarily, it is enough. We have seen burn-outs that extended over twelve or fifteen feet of Edison underground feeders, and they were bad,—"vera bad," as Robert Stephenson said in the case of the "coo." We have also seen burn-outs on 2000-volt arc light circuits that involved the destruction of thirty other similar cables in one manhole, and that was at least equally bad. Further, there is not much doubt that the higher the voltage, the greater the tendency to break-down of a cable. Hence the practice, alluded to by another speaker on the same occasion, according to which the cables in all manholes are protected by fire-proof covering over the lead, must be considered a good one, as it not only prevents the spreading of a burn-out from cable to cable, but also tends very materially to prevent mechanical injury to the lead covering of the cables by workmen in the manholes, to which cause experience has shown many of the serious burn-outs in the past to have been fairly attributable.

Motor Driving for Shoe Factories

Considering the advantages of the electric motor for machine driving of all kinds it is somewhat remarkable that shoe-making plants have so generally remained belt-driven by the factory engine when so much has been accomplished in other industries with both direct and alternating-current equipment. That a wider adoption of motor driving in the shoe trade has not been effected is doubtless due to the fact that the electrical manufacturers have had little opportunity to push this branch of motor work in view of the enormous field which has opened up in other directions during the past few years in the matter of factory operation by electric methods.

Although the manufacture of shoes is one of the most complicated of industries, requiring in many cases 110 separate handlings and 56 machine operations per pair of shoes turned out, there should be little difficulty in applying the motor-drive to a factory, at least according to the group plan. The marvelous intricacy of modern shoe machinery is a revelation to one whose experience lies in other lines of manufacturing, and doubtless it is true that the design of direct-connected motors for operating such equipment is a formidable, though by no means impossible, task.

The point is, however, that group driving is peculiarly adapted to the needs of the shoe factory, and in view of the close competition existing in the manufacture of this commodity, the great economies of electric power are certain to commend themselves to the trade if a proper stimulus is applied by the electrical manufacturer. Even if the saving in power works out as a small matter in some individual cases, the acceleration of production which almost always results in an electrically-driven establishment, is pretty likely to be realized, to the lasting benefit of the business.

It is needless at this time to expatiate upon the good points of the electric motor; experience in many varied industries has shown no power so universally satisfactory from the standpoints of cleanliness, flexibility, safety, compactness and efficiency. It would be difficult to name any other machine as reliable from the viewpoint of daily service under exacting conditions and frequent overloads. What is needed is an introduction between the shoe manufacturer and the motor, and it rests with the electrical producer to accomplish it.

In view of the great advance in prices during the past ten years, especially in the necessities of life, it is pleasing to note that the conditions in the electrical field are exactly the reverse. There is not a department in which electricity is supplied for public service that is not cheaper and better now than it was at the beginning of the year 1895. For example, one may ride either overhead, underground, or on the surface electric cars a much longer distance for five cents than formerly, due in part to a more generous transfer system. Although the cost of fuel, rent, wages and taxes has increased during the ten years, the price of current has been lowered; in consequence, electric light and power all over the country are both less expensive and better adapted to their respective purposes than they were in 1895. In telephony, also, the service is quicker and the transmission better, the subscribers are more numerous and the rates cheaper than they were a decade ago.

The North Mountain Power Company, of San Francisco, supplying current to Humboldt County, Cal., diverts the water of Canyon Creek through a flume 7½ miles in length, obtaining an effective head of 600 feet.

Book News

Experiments with Alternate Currents of High Potential and High Frequency

A Lecture, by Nikola Tesla. Size 5½ x 7¼ inches; 162 pages; 38 illustrations. Published by the McGraw Publishing Company. Price, $1.

This little book is a reprint or a new edition of the famous lecture delivered by Mr. Tesla before the Institution of Electrical Engineers, London. By a strange oversight the date of the lecture is not given in the book. In this new edition a communication from Mr. Tesla to "The Electrical World and Engineer," of March 5, 1904, on "The Transmission of Electrical Energy Without Wires," is published as an appendix of thirteen pages. Besides the lecture and the appendix there is a concise biography, accompanied by a photograph of the author. The biography evidently accompanied the original edition of the publication and has been seemingly reprinted without revision, since the age of the author is therein given as 35 years, while the date of his birth is stated to be 1857. Obviously the author is to-day 48 years of age. The appendix is interesting, but not satisfying, inasmuch as it treats largely of unrealized expectations.

Alternating Current Testing

By Fitzhugh Townsend. Size 5½ x 8½ inches; 32 pages. Published by the D. Van Nostrand Company. Price, 75 cents.

The contents of this pamphlet are fairly well indicated by its title. It is intended for the use of students and describes a series of eight experiments relating to tests of alternators, converters, etc.

Modern Practical Electricity

By R. Mullineux Walmsley, D. Sc., F. R. S. E. 4 Volumes. Size 7½ x 10 inches; 1208 pages, 1208 illustrations. Published by W. T. Keener & Co. Price, $12.

In a subtitle of his work the author has called it a popular and practical treatise. The term popular, however, is in some respects a misnomer as the author presupposes a knowledge on the part of the reader of physics and chemistry and of the higher mathematics.

In Vol. I. and II. and part of Vol. III., the author reviews the main experimental and historical facts of electrical science. This is quite complete.

The latter half of Vol. III. and the whole of Vol. IV. are devoted to the technology of electricity; that is, an account in detail of the methods by which the principles of electrical science have been and are being applied for practical use. The first chapter deals with direct-current generators, their characteristics, mechanical details and regulation.

Alternating-current generators also are dealt with, their magnetic circuit, excitation and regulation and elementary theory being taken up in turn. Batteries of generators, both direct and alternating-current, are discussed in another chapter.

The various types of direct and of alternating-current motors are treated from an electrical and a mechanical standpoint.

The section on electrical measurements is fairly complete, fully one third of the volume being taken up by this subject. Every type of instrument used in electrical measurement is here illustrated, both the details of construction and principle of operation being described.

An alphabetical index affords a ready means of reference to any part of the subject.

The Theory of Alternating Currents

By Alexander Russell, M. A., M. I. E. E. Size 6 x 9 inches; 407 pages. Published by the Macmillan Company. Price, $4.

This is a work that will appeal to the well-educated electrical engineer. In the present volume the learned author has set himself the task—no small one—of collecting and examining the more general mathematical theorems which electricians use in everyday work. The lists in nearly every chapter which the author gives of papers and works consulted and analyzed in the preparation of the book are a fair index of his wide research and study, the benefit of which accrues to the reader and student of the volume. For example, in the preparation of Chapter II., which deals with the alternating current in an induction circuit, the calculation of inductance, etc., Clerk-Maxwell's "Electricity and Magnetism;" Oliver Heaviside's "Electrical Papers;" Lord Raleigh's "Scientific Papers;" Eric Gerard's "Leçons sur l'Electricité," and Andrew Gray's "Absolute Measurements in Electricity and Magnetism" have been thus consulted. This list, compared with those following many other chapters, is a short one.

An idea of the extended scope of this book may be gathered from a statement of some of the subjects considered. Thus, Chapter I. discusses electrostatics, potential, Gauss's theorem, Kelvin's formula, hysteresis, etc. Chapter IV. treats of coefficients of self and mutual induction for electrostatic charges; capacity of a concentric main; condenser currents in concentric cables, in three-phase working, etc. Chapter VII. takes up Argand's method of representing a complex variable; vectors; the currents in a branched circuit when mutual inductance is taken into account, etc. Other chapters treat of three-phase alternators; the capacity currents in the sheaths of cables; the magnetic fields round polyphase cables; the losses in cables; eddy currents, etc.

Familiarity with the elementary theory of electricity and magnetism and a working knowledge of trigonometry and of the elements of calculus are presupposed on the part of the reader. Still the book is not entirely mathematical, and in the aggregate there are many pages of clear statements of practical value.

Electric Lighting

A Practical Exposition of the Art. Vol. I. The Generating Plant. By Francis B. Crocker, E. M., Ph.D. Size 6½ x 9¼ inches; 482 pages; 213 illustrations. Published by the D. Van Nostrand Company. Price, $3.

This is the sixth edition of Professor Crocker's popular work, the first edition having been published in 1896. Much new matter has been added to the book, as must be apparent from the fact that the present edition contains 42 pages and 61 illustrations in excess of the first edition. Furthermore, this addition to the size of the book does not fully denote the actual amount of new matter introduced, since in this edition, as the author explains, particular care has been exercised in eliminating the deadwood consisting of antiquated illustrations and statements which are too often left in revised editions of technical works. It could hardly be said of any other than a work descriptive of an electrical art that a book which eight years ago was up to date might now contain much that is antiquated in its illustrations and statements.

In the present edition much new matter has been introduced relating to recent developments in station design, steam turbines, gas engines, direct-connected generators and storage batteries. The storage battery is notably well treated, 28 pages being allotted to this subject.

Among the other subjects treated in the book are the history of electric lighting; general units and measures; the location and general arrangement of electric lighting plants; possible sources of electrical energy; steam engine construction; gas, oil

and hot-air engines; water-wheels and wind-mills; principles of dynamo-electric machines; switchboards and lightning arresters. Each subject is treated in a full, practical and lucid manner, and the information relative to the majority of the subjects is quite as applicable to railway and other electricity-generating plants as to electric lighting. The book should therefore prove of much value to engineers in other branches of the electrical arts, as well as to mechanical engineers, architects, etc.

This treatise has already been used as a text-book in a number of engineering schools, which is a good test of its practical utility as an educator. The diagrams are clear and well executed, and the illustrations illustrate, which cannot always be said of technical books.

The Insulation of Electric Machines

By Turner and Hobart. Size 5½ x 9 inches; 297 pages. Published by the Macmillan Company. Price, $4.50.

This is an important work on a really important subject by men who have had a large theoretical and practical experience with the matters of which they treat. As frequently happens, the title of the book does not convey a very clear idea of the authors' object, or of the complete manner in which they have carried it out, namely, to set forth in serviceable form the information and experience which they have accumulated in twenty years of practical connection with the winding and insulating processes employed in the manufacture of electric machines in the largest electric works in Great Britain, America and Germany. They have besides incorporated in the book a large amount of information gathered from the writings of co-workers in this field.

The book is replete with tables and illustrations pertaining to the various subjects discussed, among which may be mentioned some properties of insulating materials; the insulation of "magnet wires" employed in armature and field windings; mica and mica compounds; the insulation of commutators; heat-dissipating impregnating materials; the insulating properties of papers and of thin sheets of other fibrous materials; the insulating properties of celluloid; the "space" factor; drying insulations in vacuum ovens, and specifications for insulation.

These subjects, taken at random from the book, will give a fair idea of its scope, but to be properly appreciated the book will have to be seen and studied. It should perhaps be remarked that the work is confined strictly to the insulation of electric machines and apparatus, and does not touch upon the insulation of cables; in fact, that subject is avowedly excluded. At the same time there is no question but that those interested in cable making and using will find considerable food for reflection and possibly information and suggestions advantageously applicable to the last-named art.

At the outset the authors express the opinion that what is wanted, in electrical machinery is high disruptive strength, that is, great power of withstanding high voltages without sustaining injury or initiating deterioration, and the aim of their book is to make clear the causes that have often heretofore stood in the way of attaining this desideratum and to outline the means by which it may be attained.

The Proceedings of the Society for the Promotion of Engineering Education

Size 6 x 9 inches; 253 pages. Published by the Engineering News Publishing Company. Price, $2.50.

The twelfth annual meeting of the Society for the Promotion of Engineering Education was held at the St. Louis Exposition on September 1 to 3, 1904, and the proceedings at that time are contained in this book. A number of papers were read and the following officers were elected:—President, Fred W. McNair, Michigan College of Mines, Houghton, Mich.; vice-presidents, Clement R. Jones, University of West Virginia, Morgantown, W. Va.; Elwood Mead, University of California, Washington, D. C.; secretary, Milo S. Ketchum, University of Colorado, Boulder, Col.; treasurer, Frederick P. Spalding, University of Missouri, Columbia, Mo.

The retiring president, C. Frank Allen, delivered an address on "The Outlook for Engineering Education," and the following papers were read:—

"A Practical Method of Instructing Engineering Students in the Biography and History of their Profession," by Robert Fletcher.

"A Business Proposition: Some Suggestions for Increasing the Efficiency of the Society," by J. A. L. Waddell.

"The Crowding of the Curriculum," by Alexander C. Humphreys.

"The Extension of Engineering Investigational Work by Engineering Schools," by Arthur N. Talbot.

"Industrial Catalogue Library," by John G. D. Monk.

"Report of Committee on Requirements for Graduation," by William G. Raymond.

"Field Work in Civil Engineering at Iowa State College," by Anson Marston.

"The Naval Academy as a Technical School," by Ira N. Hollis.

"Report of Committee on Technical Books for Libraries," by C. F Burgess.

"The Preparation of Engineering Text-Books," by Emery H. Powell.

"Absolute and Gravitational Systems of Units," by Edward R. Maurer.

"On Teaching Calculus to Engineering Students." Separate papers on this subject were read by Alfred M. Kenyon and Benjamin F. Groat.

"The Work of the Dean of the Faculty of the Massachusetts Institute of Technology," by Alfred E. Burton.

Parcel Delivery by British Street Railways

WRITING under recent date from Hull, England, United States Consul W. C. Hamm says that the Manchester street railway committee has put in operation a system for carrying and delivering parcels. They have adopted a scale of charges for parcels, inclusive of the charge for delivery, for two areas, the "inside" and the "outside." The "inside" area will include the whole of the city of Manchester, the borough of Salford, and the township of Stretford as far as Warwick Road. The "outside" area will include the suburbs which are around the district thus outlined and within the tramway's circuit. Parcels will be delivered to all parts covered by the scheme at intervals of not more than a quarter of an hour.

The following are the charges for the two areas:

Weight Not exceeding—	Inside Servicc	Outside Service
14 pounds	4 cents	6 cents
28 pounds	6 cents	8 cents
56 pounds	8 cents	12 cents
112 pounds	12 cents	16 cents

Manchester, with Salford and Stretford, all included in the "inside" area, has a population of about 800,000 people. The "outside" area includes a number of suburban towns and villages.

One recent steam turbine inventor has gone a bit further than all his predecessors in widening the field for his machine by proposing its use for locomotives, claiming at the same time the necessary qualifications of reversibility and ability to run at reduced speed without loss of efficiency.

Electrical and Mechanical Progress

New Rotating Field Alternators

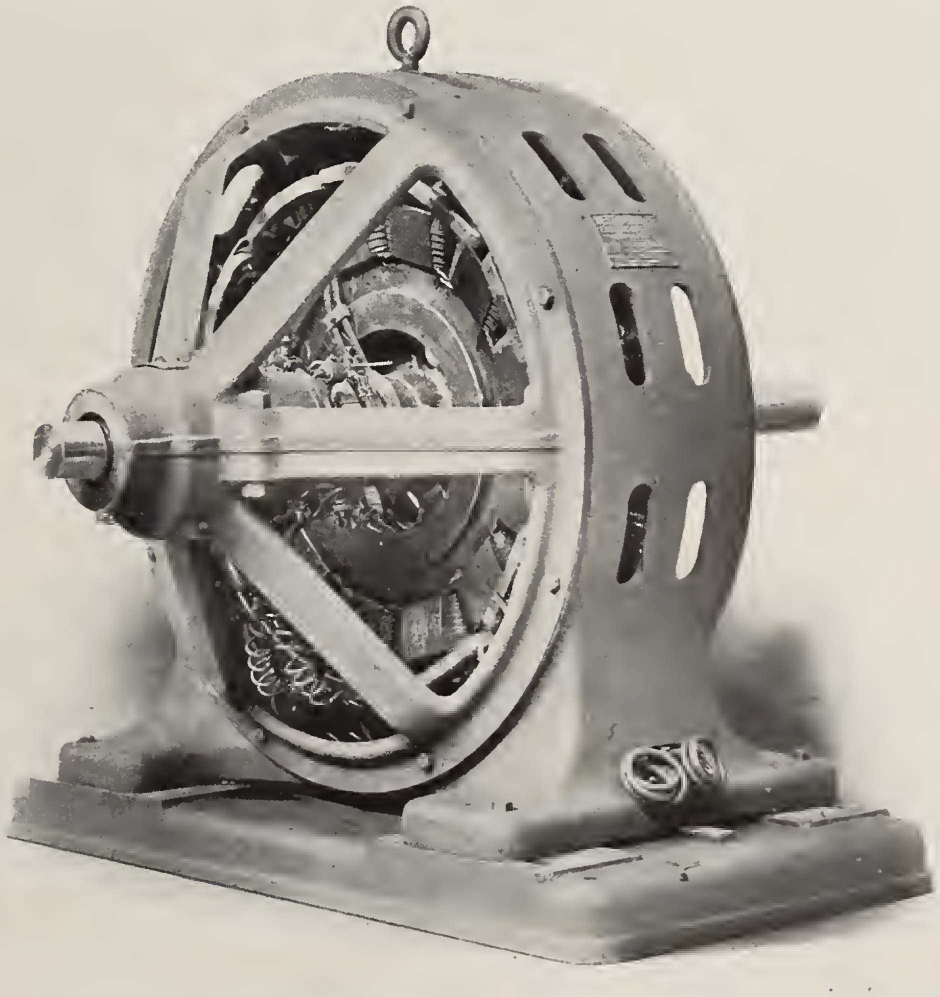
BELTED-type, self-contained, rotating-field, alternating-current generators, shown in the annexed illustration, have recently been placed on the market by the Westinghouse Electric & Manufacturing Company, of Pittsburgh. The machines are built for single, two and three-phase circuits, in sizes from 30 to 200 K. W. The single-phase generators are built for 220, 440, 1100 and 2200-volt circuits at 7200 alternations. The polyphase machines are wound for 6600 volts, and both 3000 and 7200 alternations.

In these generators the armature is stationary, facilitating the insulation of the windings and making them, it is claimed, especially adapted to high voltages or large current output.

The frame of the stationary armature is cast in one piece with slots machined on the inside for holding the punchings which receive the windings; these are composed of wire, strap, or bars, depending on the size and voltage of the generator. Open slots are employed in machines up to 75 K. W. with coils held in place by hard fiber wedges. In the larger machines partially closed slots are used. Horizontally split brackets for carrying the bearings are bolted to this cast-iron frame. The bearings are generous in their dimensions and are self oiling, each having oiling rings and an oil gauge. All generators have bed plates with large foundation areas and suitable belt tighteners. They may also be arranged for direct connection to an engine or water wheel.

The fields of the small generators are of cast steel, with pole caps of the same material. The poles of larger sizes are laminated and keyed, or dovetailed to a cast-iron spider. The field coils are composed of square wire so wound as to expose the maximum surface. In the generators having laminated poles, heavy brass wedges, which hold the field coils in place, retard any shifting of the field between the poles, and thus, it is claimed, practically eliminate pumping between the generator and any rotary converters or synchronous motors which may be connected in the system and insure satisfactory parallel operation of two or more generators. A large shaft insures cool running of the bearings, and the absence of any distortion which might result from the pull of the belt.

Every means has been utilized for the rapid dissipation of heat from all parts of the machines. Open spaces in the laminated field register with those in the armature, and during operation air is drawn in through the field spider and forced out through



A NEW SINGLE-PHASE, SELF-EXCITING ALTERNATOR, WITH ROTATING FIELD. BUILT BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURGH

A TELPHERAGE SYSTEM INSTALLED BY THE UNITED TELPHERAGE DEPARTMENT OF THE DODGE COAL STORAGE COMPANY, OF PHILADELPHIA, AT THE MASON MACHINE WORKS, TAUNTON, MASS.

the stationary core and windings, in preference to saturating the magnetic field.

The single-phase generators have compensating field windings supplied with rectified alternating current. A commutator on the shaft adjacent to the collector rings has its brushes connected to the secondary of a series transformer in the armature circuit and its segments to the self-exciting field coils. The compensating winding is so designed as to allow the generator to be adjusted for a practically constant voltage from no load to full load, or for an increase in voltage.

A Telpherage System in Machine-Shop Work

IN machine-shop work, the cost of production is largely affected by the time occupied in bringing raw material to the machines, in conveying partly finished pieces from one machine to another, and in conveying finished parts to the assembling floor. A system which has largely reduced the time thus occupied has been installed by the United Telpherage Department of the Dodge Coal Storage Company, of Philadelphia, in the plant of the Mason Machine Works, at Taunton, Mass.

The work at this plant calls for the expeditious handling of heavy miscellaneous loads incident to modern mechanical establishments. One man, the operator, attends to the hoisting, lowering and transporting of such loads as ball-weights, billets, castings and flasks; in fact, anything needed in a foundry and machine shop. The loads vary in weight from 100 to 3500 pounds. The lighter castings are wheeled in barrows on the telpher, the heavier ones being attached, as shown in the illustration, by chain slings. The hoisting speed is 60 feet, and the conveying speed 800 feet a minute.

Where it formerly required five men 20 minutes to get a casting on a wagon body, telpherage conveys the huge bulk in one and one-half minutes along the line 1000 feet from the starting point, and lowers it in a convenient place for the next operation in its manufacture. It would have taken the five men as long to unload this weight as it would to load it, and the old way of handling by teams would also have taken much longer.

The following table compares the expenses of the two methods:—

OLD METHOD		
Labour 3 minutes	60c.	
Service of team one hour	12c.	
		72c.
COST BY TELPHERAGE		
Labour 3 minutes	3c.	
Interest and depreciation	5c.	
		8c.
Saving in this particular item of work		64c.

What it would mean in the aggregate, for a term of months or years, can be readily appreciated. The same economy that makes the beginning of telpherage work attractive is maintained throughout its operation, whether the line be straight or sinuous. When it becomes necessary for the telpher to reach other parts of the works, it is switched on the track leading into the particular shop or department where, under the direction of the operator, it carries castings to and from the various machines as well as the assembled apparatus to the shipping room, saving the expense that would otherwise be entailed by the use of a traveling crane. This further results in lessening cost, because of uninterrupted employment of the skilled labour necessary in the fashioning of high-grade product in this establishment.

Lifting Magnets for Skull-Cracker Work

BREAKING up cast-iron scrap by the dropping of a weight upon it is a time-honoured practice in foundry work. As ordinarily used, the weight, in the form of a ball, is fitted with a ring or eye so that it may be hoisted up and freed by the tripping of a latch. A much quicker and more accurate method, however, which has but recently come into use is that of employing a lifting magnet to raise the weight and free it at the desired time and height. The illustration on this page shows a lifting magnet, made by the Electric Controller & Supply Company, of Cleveland, Ohio, and used for this purpose.

A LIFTING MAGNET MADE BY THE ELECTRIC CONTROLLER & SUPPLY COMPANY, OF CLEVELAND, OHIO, USED IN SKULL-CRACKER WORK. THE BALL WEIGHS 11,000 POUNDS

By the slow and costly old methods, skulls, old ingot molds, defective castings, and the like, broken up and loaded into the charging boxes ready for re-melting, cost about as much or more than regular stock. Many skulls are broken up at a loss, since this loss is less than the cost of burying them. The jerk of the latch-hook rope often destroys the aim, so that many blows are ineffective and much time is wasted.

With the lifting magnet, however, it is only necessary to open the circuit and the ball drops accurately. The magnet is instantly attached by simply lowering on the ball, thus obviating the loss of time frequently necessary for prying the ball into such a position that the ring or eye may be engaged by the hook of the crane or hoist where a mechanical trip is employed.

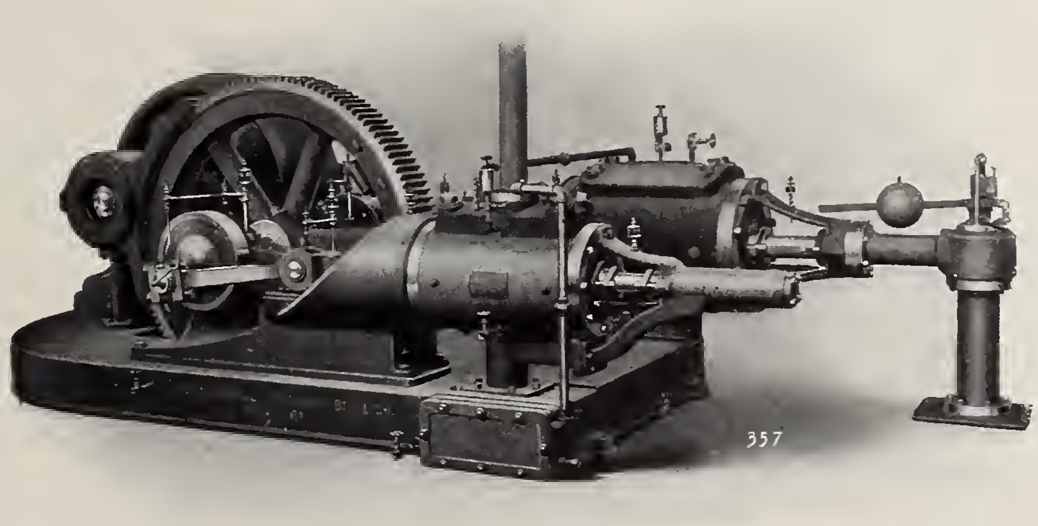
The entire operation is conducted from a safe distance by the crane man, and the magnet may also be used for placing the piece to be broken in position and for picking up the pieces after breaking.

The Motor-Driven Air Compressing Plant at the Chicago & Northwestern Railway Terminal

THE electrically-driven air power plant at the terminal station of the Chicago & Northwestern Railway in Chicago is an interesting example of modern practice in the application of electric power to the compression of air for the many purposes so characteristic of railway yard work. The plant is located in a small brick building in the rear of the main terminal station, close to the river and adjacent to the extensive passenger yards of the company. This building comprises two rooms, in one of which are the steam boilers for the heating system of the station. In the other section is located the electrical and pneumatic apparatus.

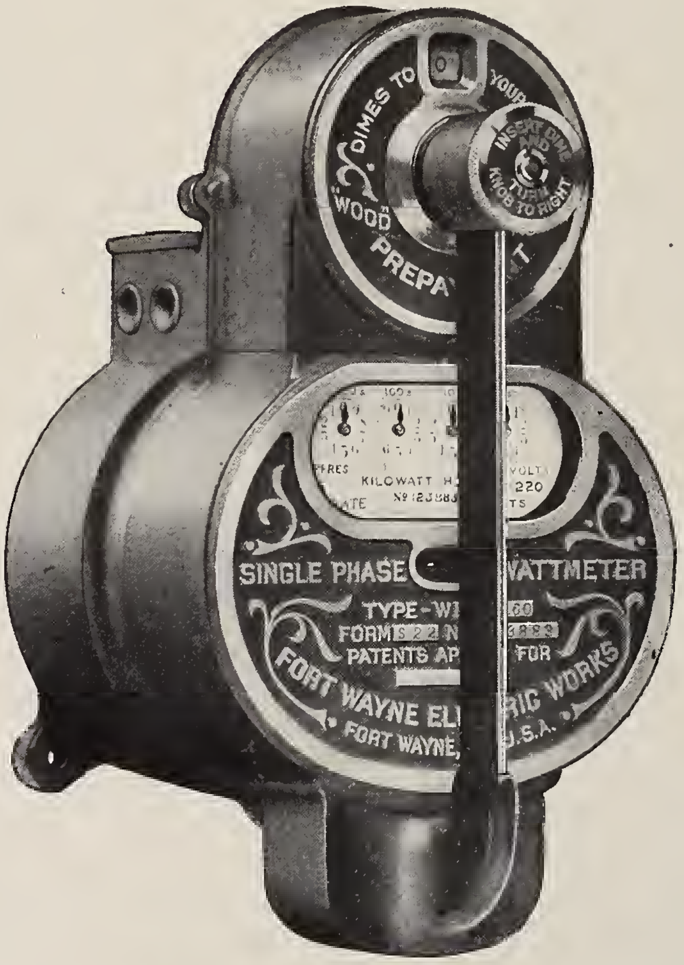
Alternating current is taken from the city mains of the Chicago Edison Company, and is stepped down by transformers to the working voltage. Part of it is used directly on low-voltage alternating circuits, the remainder being converted by rotaries or motor-generators and delivered as direct current for power purposes.

The air compressor plant is made up of two Ingersoll-Sergeant standard power-driven compressors. They are duplex, two-stage machines, with air cylinders, frames and bearings mounted on a solid cast iron bedplate which incloses the horizontal intercooler between the cylinders. Both high and low-pressure cylinders are fitted with the standard Ingersoll-Sergeant piston inlet valve, and regulation is secured by a choking con-



AN AIR COMPRESSOR BUILT BY THE INGERSOLL-SERGEANT DRILL COMPANY, NEW YORK, AND DRIVEN BY A MOTOR BUILT BY THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

troller on the low-pressure intake. This device, acting to throttle the air intake passage, is controlled by receiver pressure and automatically regulates the volume of air compressed, and consequently the amount automatic oiling system, with a central tank feeding to all bearings. The drip is recovered and filtered. Sight-feed oilers care for cylinder lubrication. The machines are side by side, the switch-board, rheostats, meters, etc., being mounted in front of and between them. An intake duct, supplying both compressors, leads under the floor to the open air used almost entirely in the system of switches and signals, but a small portion is diverted to the boiler room, where it is used in a small air-lift pumping outfit which supplies water to the terminal. The engineers in charge report an excellent performance of this equipment, which has been in severe and continuous service for several years.



FIGS. 1 AND 2.—TYPES OF THE NEW PREPAYMENT INDUCTION INTEGRATING WATTMETER MADE BY THE FORT WAYNE ELECTRIC WORKS, FORT WAYNE, IND.

of power consumed, according to the demand for air from the power system. The compressors run at constant speed, the controller simply varying the effective piston displacement with varying load. The machines have a stroke of 12 inches, and the air cylinders are 12¼ and 18¼ inches in diameter. At a speed of 130 revolutions per minute the free air capacity of each unit is 455 cubic feet per minute. The pressure used in this plant is 70 to 80 lbs. gauge.

The sub-base is extended in each compressor to support the driving motors, which are General Electric direct-current machines, rated at 80 H. P. at 510 revolutions per minute, and 220 volts. A pinion on the motor shaft gears directly with the teeth on the compressor fly-wheel, which is of standard weight for machines of this capacity. The gears are protected by proper guards.

Independent concrete foundations are used. Each unit has its own and rises beside the power house, terminating in a screen cover for the exclusion of dust and cinders coming from the yards.

The discharge pipes unite in an air main leading to the primary receiver outside the plant. Provision is made for draining this receiver. From this point the line leads to a system of cooling tubes to the west of the power house, made up of a large upper and lower horizontal header, connected by a number of small vertical pipes. This arrangement, freely exposed to the air, precipitates whatever moisture may remain in the air after leaving the primary receiver, the water being withdrawn from the lower header.

From the cooler air lines radiate throughout the yard, supplying power to the pneumatic switch and signal system controlling the movement of trains in the terminal track system. Secondary air receivers are also located at suitable places. The air is

Prepayment Wattmeters

THE fact that the prepayment mechanism of prepayment wattmeters required too great a torque for its operation and affected the light load registration of the meter has been the cause of failure of many designs. The Fort Wayne Electric Works, of Fort Wayne, Ind., are now placing on the market a prepayment wattmeter which, it is claimed, requires such an extremely low torque for the operation of its prepayment mechanism that the smallest amount of energy which will cause the meter to run will operate the device perfectly.

The new prepayment mechanism is compact in form, neat in appearance and has been applied to the Type K induction integrating wattmeter as well as the new "Wood" Type W meter. Fig. 1 is an outside view of the former, while Fig 2 shows the same mechanism applied to the latter.

These meters are at present designed to operate with a 10-cent piece, and may be credited with two dollars' worth of energy at one time. The capacity of the money box is $10. A meter operated by a 25-cent piece will soon be placed on the market, however, as considerable demand has already been made for this. It may be credited with $5 worth of energy at one time, and has a total capacity of $12 in coin.

Upon inserting a coin in the slot at the top of the meter the coin acts as a key, locking the crediting device to the knob so that one-half turn of the latter credits the coin on the dial and deposits it in the money box. This operation is accomplished as follows:—

On the farther end of the crediting spindle is a pinion which engages an intermediate gear. This intermediate gear also engages the inside annular gear of an escapement mechanism, shown in Fig. 3. The coin, acting as a key in rotating the pinion, causes the intermediate gear to roll about the pinion as an axis. This forces the numbered dial ahead under the tension of a flat coiled spring. Thus power for the debiting operation is stored up in the spring. This operation of crediting box. It is only by turning the knob one-half revolution that the consumer can obtain credit for his payment. After twenty 10-cent pieces have been credited the slot is closed, preventing the insertion of another coin until 10 cents' worth of energy has been used.

The same operation that credits the first coin in the meter causes the circuit to be closed by means of a cam on the crediting drum. This cam operates a lever arm, which, in turn, engages a switch bar and closes both circuits under the tension of a coiled spring. Fig. 3 shows the details of this switch.

After the amount of energy purchased has been used, and the drum, in debiting the coins, has returned to its initial position, the same cam releases the spring and causes the switch to open.

The only connection between the prepayment device and the recording train of the wattmeter is a pinion in the former which engages a gear in the latter. In the operation of debiting, every revolution of this pinion causes a stop to be removed from the gear train in the prepayment device by means of a cam mounted upon the pinion shaft. The gear train thus released is free to revolve. This train is shown in Fig. 4, and consists of three gears and three pinions; one of the latter, however, simply operates a retarding fan.

For debiting, the intermediate gear, in rolling about the center stud under tension of the coiled spring, carries with it the internal annular gear and causes the whole escapement motion of the prepayment device to operate, providing the latter be unlocked by one rotation of the small pinion, as explained above. The ratio of gears in the escapement train is fixed at such a value that when the dial has moved sufficiently to allow the next lower number to appear thereon, a pin upon the periphery of one of the large gears acts as a cam, forcing a stop lever into such a position that the latter immediately engages a pin on one of the lower gears and stops the whole mechanism. Thus it will be seen that, for every revolution of the small pinion engaging the wattmeter recording train, one number is subtracted on the dial and the switch cam is brought just so much nearer to the position in which it operates the switch and opens the circuits.

One of the features of this prepayment meter is its ability to both credit money and debit energy at the same time. This is possible because the only connection between the crediting stud and the debiting escapement motion is an intermediate gear whose axis is not fixed.

In crediting, the intermediate gear rolls about the central pinion; in debiting the annular gear, together with the intermediate gear, rolls about the central pinion. Thus, when both operations take place at one time the pinion and the annular gear turn in opposite directions at equal speeds, causing the intermediate gear to simply revolve upon its own axis without changing the numbers on the dial in any way. Although the debiting device is usually locked during the crediting operation, it will be seen that the value of the meter is

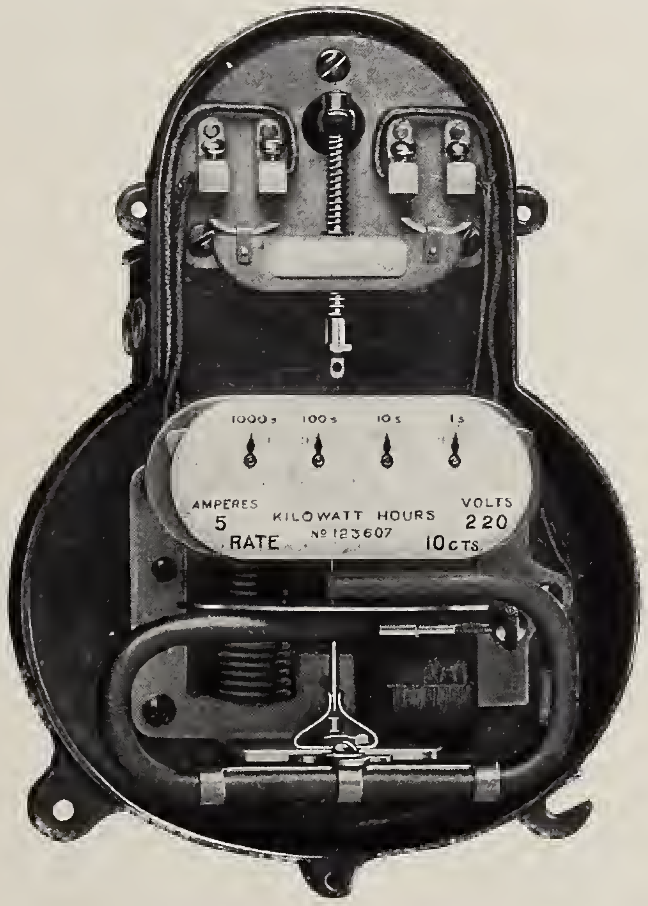


FIG. 3.—THE SWITCH FOR CLOSING THE METER CIRCUITS IS SHOWN AT THE TOP OF THE METER

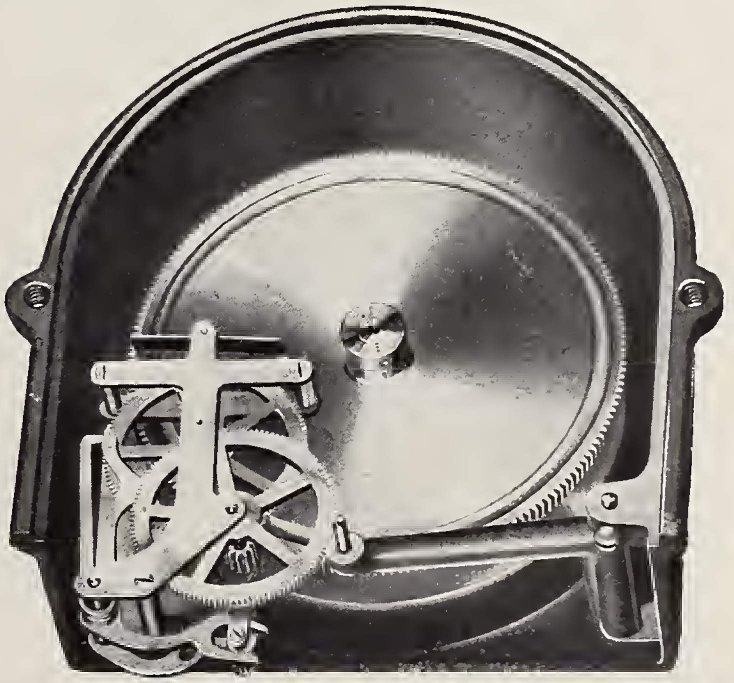


FIG. 4.—THE ESCAPEMENT MECHANISM OF THE PREPAYMENT DEVICE

may be repeated until the dial at the top of the meter shows twenty dimes credited.

After the coin has once been inserted and the knob turned, it is locked within the meter, and can only be obtained by opening the money

greatly increased by its ability to perform both operations simultaneously when such an occasion arises.

The money box has been designed with the idea of making it as nearly proof against tampering as possible, for it is not possible to gain access to the lock without first breaking an auxiliary seal. The lock is of the concealed Yale type, which cannot be picked, and can be opened only by one special key in the possession of employees. The operation of removing the box, however, can be accomplished without interfering with the meter in any way.

The meter can be readily adjusted for any rate up to 20 cents per K.W.-hour, and the principle of combining the time switch with the integrating wattmeter will, it is claimed, gain for itself an entirely new field of service, especially in sign lighting.

A New Steam Meter

An improved form of the Sargent steam meter, described in the March, 1905, issue of this publication, has been put on the market by the Sargent Steam Meter Company, of Chicago, Ill. It is designed to show on a dial the weight of steam or compressed air which has passed through it, or the horsepower.

To determine the amount of steam used by an engine, a steam turbine, a heating plant, a drying kiln, or, in fact, any department of an industrial works, a test is often necessary; and while it can be done when the whole amount of steam can be condensed, by the installation of expensive and complicated apparatus, the cost of such determination is often prohibitive. If the steam is condensed in water or by a jet condenser, the only way to determine the quantity is by weighing the water before evaporation, which, on account of using the boiler output for other service, is usually impracticable.

The Sargent meter, however, indicates directly the weight of steam passing through a pipe, at any pressure within the limits of the device. It is calibrated by weighing the steam passed through and condensed in a surface condenser, the indications in service therefore coinciding with the indications determined in calibrating the meter.

Fig. 1 shows the improved form of the meter with the bottom bonnet removed. It is connected up in the steam pipe or by-pass, which allows all the steam that is to be measured to pass through, and this amount is indicated by the position of the needle on the dial. Meters are made "Right" and "Left," so that when looking at the dial the steam may flow towards the right or left as the purchaser desires.

Fig. 2 is a sectional elevation of the meter, showing the passage of the steam and the moving parts. Steam enters from the left, and, rising up around the valve stem guide, passes through the small hole *P*. As the pressure increases, the valve *i* is raised, allowing the steam to pass down between the two cones and the valve seat to the discharge side of the meter. As the valve stem is open to the atmosphere, the pressure on the discharge side of the meter tends to close the valve and force it to its seat. As the area of the valve stem is about 2 per cent. of the valve area, it follows that there

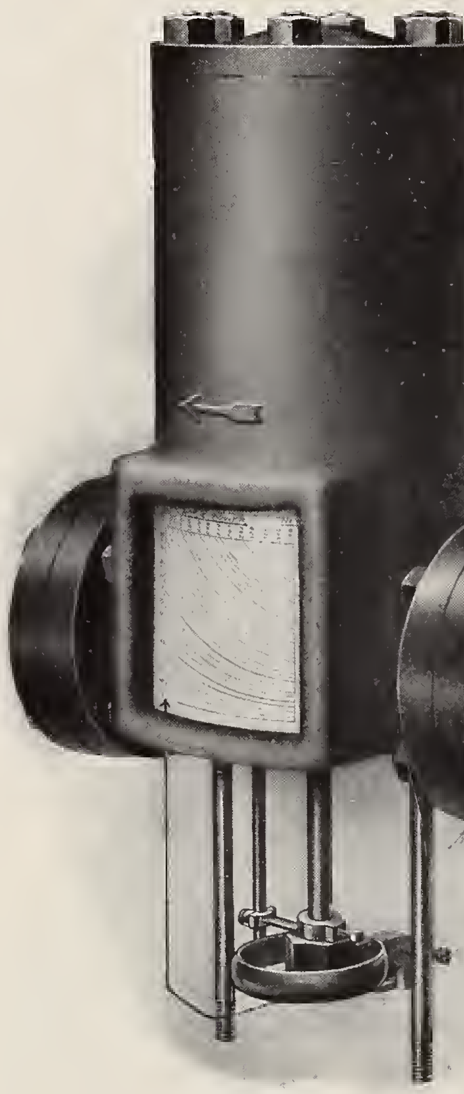


FIG. 1

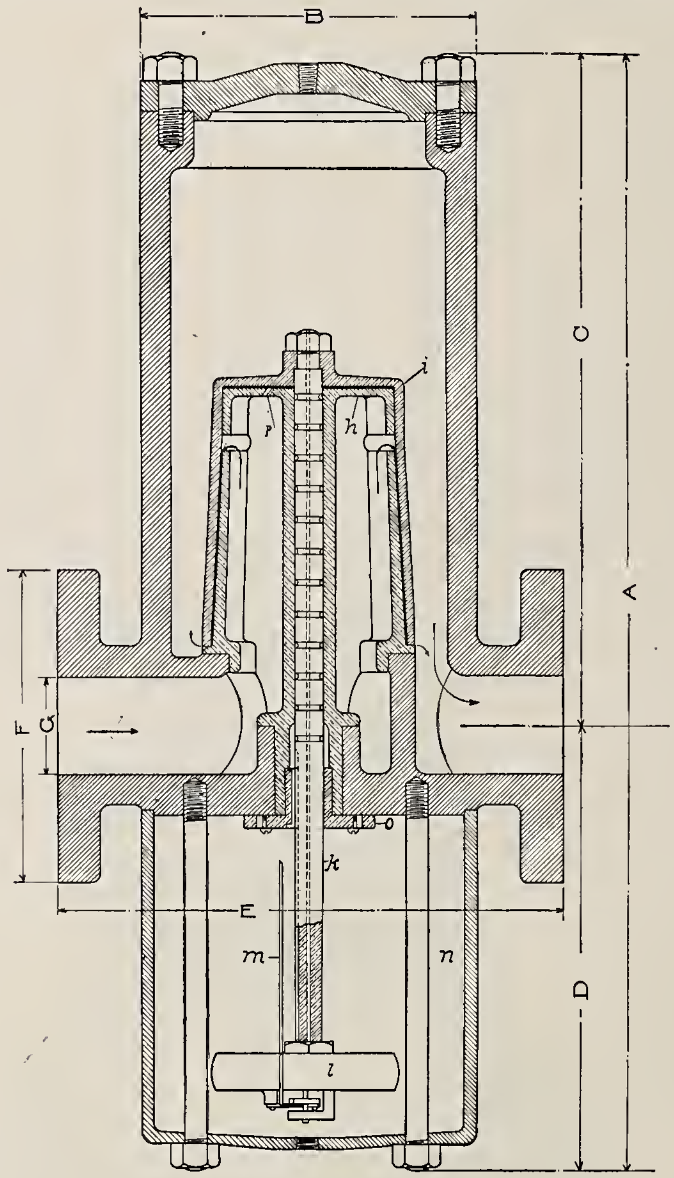


FIG. 2

ELEVATION AND SECTIONAL VIEWS OF THE STEAM METER MADE BY THE SARGENT STEAM METER COMPANY, CHICAGO, ILL.

will be a 2 per cent. difference in the pressure between the outlet and inlet side of meter, and that to maintain the difference the valve will assume new positions, depending

FIG. 3.—THE VALVE, VALVE STEM AND SPRING OF THE SARGENT STEAM METER

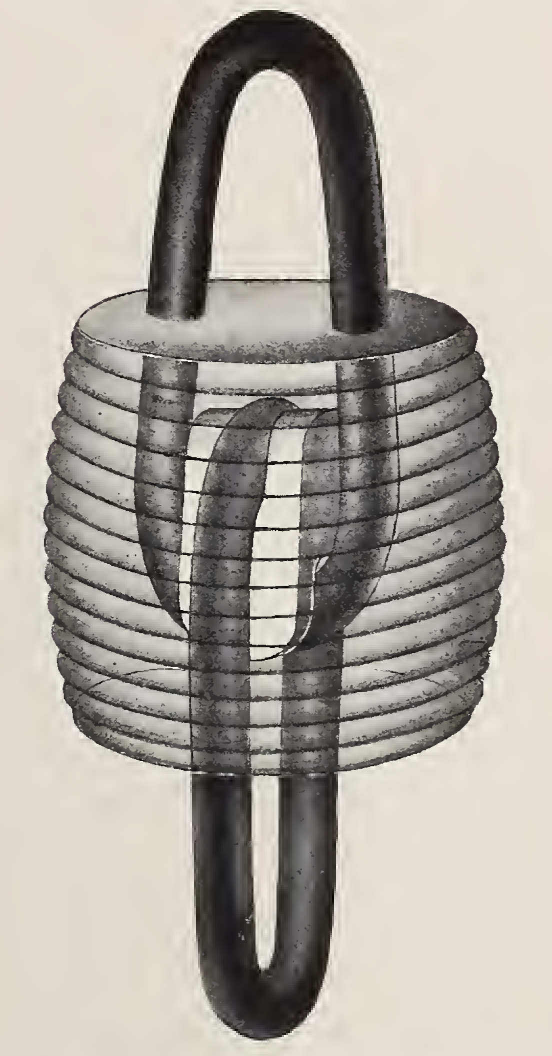
on the quantity of steam flowing through. If the steam pressure were constant, the rise of the valve would be in proportion to the weight of steam flowing through, but, as the pressure increases, more steam will go through a constant opening; or, what necessarily happens, is that as the weight remains constant the opening becomes less as the pressure increases.

In order to compensate for variations in pressure a Bourdon spring, shown in Fig. 3, is connected to the bottom of the valve stem, moving the needle transversely as the pressure varies. With a constant weight of steam flowing through, the valve would be open twice as wide for 50 pounds pressure as for 100 pounds pressure, from which it will be seen that the horse-power lines go down as the pressure goes up. The meter is calibrated by weighing the condensed steam flowing through under different pressures and valve openings, and the trial dial thus obtained is transferred to the permanent metal dial of the meter. As the meter has but one moving part it is not liable to get out of order. It is manufactured in sizes from 1 to 6 inches.

Improved Strain Insulators

IN the manufacture of strain insulators, some important features that are necessary, if the insulators are to be used on pressures higher than 500 volts, are sometimes overlooked. A good strain insulator should have sufficient insulated distance between the two metal parts, sufficient surface insulation, obtained by long distance from metal part on one end to metal part on the other end, and sufficient strength and uniformity in the metal parts.

In the annexed illustration is shown an improved strain insulator, manufactured by the Creaghead Engineering Company, of Cincinnati, Ohio, designed to embody the features just mentioned.



A NEW STRAIN INSULATOR MADE BY THE CREAGHEAD ENGINEERING COMPANY, CINCINNATI, OHIO

The metal parts are two steel links, generally similar to chain links, made of material of high tensile strength. These links are separated and insulated from each other by a hard porcelain separator, giving considerable distance between the metal parts, and a high electrical resistance.

Around the metal parts and porcelain spreader, is moulded, under very great pressure an insulating compound that thoroughly seats the metal parts on the porcelain, filling all spaces between the porcelain and links, thoroughly weatherproofing the porcelain spreader and protecting it against mechanical injury. This insulating compound is not intended to give the insulator any material mechanical strength, but to protect the spreader. It materially increases the surface insulation, and separates the exposed portions of the strain insulator by a large distance.

The illustration represents the full size of Bourbon No. 2 strain insulator, which is tested to a breaking strain of about 4000 pounds. The Bourbon No. 4 insulator is of larger size. The lineal dimensions are increased about 50 per cent., and it is tested under average breaking strain of about 8000 pounds. These insulators can be safely used on 1000 volts working pressure, under ordinary weather conditions, and are used in series of two or more on high pressures for insulating guy and anchor wires.

The World's Electrically Developed Water Power

THE total water power used at the present time for the production of electricity is estimated at about 2,000,000 H. P. The appended table, accounting for about 75 per cent. of this amount, has been printed by "The Iron Age" as embracing those hydro-electric stations from which it has been able to obtain particulars:—

	Horse Power
United States of America	527,467
Canada	228,225
Mexico	18,470
Venezuela	1,200
Brazil	800
Japan	3,450
Switzerland	133,302
France	161,343
Germany	81,077
Austria	16,000
Sweden	71,000
Russia	10,000
Italy	210,000
India	7,050
South Africa	2,100
Great Britain	11,906
Total horse-power	1,483,390

Transmission line conditions are considered to be very good, if, for continuous use, 1 per cent. of the insulators does not have to be replaced each year. Taking a circuit having 12,000 insulators installed, there would be at least 120 renewals each year.

The World's Largest Steam Turbines for Street Railway Service

THE Brooklyn Heights (N. Y.) Railroad Company, has recently closed contracts with the Westinghouse Companies, Pittsburgh, Pa., for two 7500-K. W. turbine-type generating units for extending their present power house equipment in Brooklyn. These units will be the largest generating units of the steam turbine type in the world. With the guaranteed overload capacity of 50 per cent. above rating, the turbines will be capable of developing 16,000-brake H. P., and about 10,500-brake H. P. on normal load. They will operate on dry steam at 175 pounds pressure and a vacuum of about 28 inches. Three-phase, 25-cycle current will be generated directly at 11,000 volts for distribution to the line.

It is of interest in connection with this that the second and third largest turbine generating units in the world are also of the Parsons type, the former built abroad and the latter by the Westinghouse Companies at Pittsburgh. The Brooklyn Heights contract is especially significant from the fact that the company had already contracted about a year ago for a Westinghouse-Parsons turbine unit of the largest capacity then built—5500 K. W. The building of the new machines will mark an important step in the development of power station apparatus.

Another large steam turbine equipment for railway service is that for a 10,000-H. P. power house to be supplied by the Westinghouse Companies to the Fort Wayne & Wabash Valley Traction Company, of Fort Wayne, Ind. The entire electrical equipment, comprising both three-phase and two-phase apparatus, the former for railway, and the latter for lighting service, will be built by the Westinghouse Electric & Manufacturing Company, and the steam turbines by the Westinghouse Machine Company.

The principal apparatus covered by the contract comprises two 1500-K. W. turbo-generator units, delivering 375 volts, three-phase, 25-cycle current to rotary converters; two 1500 and one 500-K. W. turbo units, delivering 2300 volts, two-phase, 60-cycle current to step-up transformers for the lighting system. Four rotary converters; seven 375-K. W., fifteen 75-K. W., and three 150-K. K. oil-insulated, self-cooling transformers; four switchboards for 125, 550, 600 and 2300 volts, and low equivalent lightning arresters, choke coils, and disconnecting switches are included in the equipment.

The steam turbine equipment is to be of the standard Westinghouse-Parsons type, operating under 150 pounds steam pressure, a moderate vacuum and with dry saturated steam. Many distinctive features will be embodied in the arrangement of the new power house now building.

The Fort Wayne & Wabash Valley Traction Company controls all the city lines in Fort Wayne and Lafayette, Ind.; the Logansport Street Railway Company and the Logansport, Rochester & Northern Traction Company in Logansport; the Fort Wayne & Southwestern Traction property from Fort Wayne to Wabash; the Wabash River Traction Company and the Wabash-Logansport Traction Company, operating from Wabash to Logansport, and the electric lighting plant in Fort Wayne.

Contracts have also been closed with the Westinghouse Companies by the Grand Rapids-Muskegon Water, Power & Electric Company, of Grand Rapids, Mich., for two 1500-K. W., three-phase, 6500-volt turbo-generator outfits, with two 20-K. W. engine-type exciters. The voltage will be raised for transmission by three 1000-K. W., oil-insulated water-cooled transformers, and finally lowered for distribution by three transformers of the same size and type. The apparatus will be controlled from a 660 and a 6600-volt switchboard.

Trade News

The Ingersoll-Sergeant Drill Company and the Rand Drill Company recently united under the name of the Ingersoll-Rand Company. The new corporation was formed under the laws of New Jersey with a capital of $10,000,000, of which $5,000,000 are preferred stock and the remainder common. This is a union of valuable patents and of expert engineers of wide experience in this special line of work. The factories of the two companies are located at Phillipsburg, N. J.; Easton, Pa.; Tarrytown, N. Y.; Ossining, N. Y.; Painted Post, N. Y.; New York City, and Sherbrooke, Quebec. They will all be operated. The officers of the new company are: President, W. L. Saunders, formerly president of the Ingersoll-Sergeant Drill Company; first vice-president, George Doubleday, formerly treasurer of the Ingersoll-Sergeant Drill Company; vice-presidents, Jasper R. Rand, formerly president of the Rand Drill

WILLIAM L. SAUNDERS

Company; John A. McCall, president of the New York Life Insurance Company; J. P. Grace, vice-president of W. R. Grace & Company; George R. Elder, general manager of the manufacturing department, treasurer, W. R. Grace, formerly sec-

JASPER R. RAND

retary of the Ingersoll-Sergeant Drill Company; secretary, F. A. Brainerd, formerly treasurer of the Rand Drill Company. For the present the main offices of the new company will be located at 26 Cortlandt street, New York.

At the recent convention at Denver of the National Electric Light Association, a very interesting exhibit of tube cleaners, tube cutters, reseating machines, damper regulators and the like was made by the Lagonda Manufacturing Company, of Springfield, Ohio. Many of the devices shown were driven by electric motors, and it was thus pos-

sible to make the display particularly interesting to those who were there to see it. The Lagonda Company make a specialty, by the way, of cleaning boilers by contract, and as they have had extended experience in this work as well as in the manufacture of their several machines, they are prepared to give good advice on the subject wherever it may be needed.

The Cia Carris de Ferro do Lisbon, Portugal, recently ordered from the J. G. Brill Company, Philadelphia, twenty 28-foot semi-convertible cars mounted on the patented "Eureka Maxim-Traction" trucks. This type of car is particularly adapted to service at Lisbon, as the climate, while never cold enough to freeze, is subject to rapid change, the summer days being very warm with cool sea breezes at night. The semi-convertibles are to have the builders' new grooveless post arrangement which does away with the metal runways and the sash trunnions formerly used. The "Eureka" truck was especially designed for city service and has the traction necessary to start quickly and climb grades easily, necessary qualities for service at Lisbon, which is laid out on seven hills and has streets with very heavy grades.

The Peerless Electric Company, of Chicago, Ill., announce that they buy and sell and repair wattmeters of every description. They are one of the largest houses in the United States engaged in this business and have a comprehensive price list of their goods which they send on request.

During the years 1903 and 1904, the Japanese agents for the Westinghouse Machine Company, Takata & Company, sold no less than 56 Westinghouse engines, ranging from 600 H. P. to 12½ H. P., and aggregating in capacity almost 8000 H. P. They are all of the vertical single-acting type, both simple and compound. The list of customers comprises government arsenals, railroads, electric light companies, bureaus, water works, mines, universities and hospitals.

The Westinghouse Electric & Manufacturing Company, of Pittsburgh, has just closed a contract for the equipment of the main generating station and four rotary converter sub-stations of the Cincinnati Northern Traction Company. The power house will be located at Hamilton, Ohio, and the original installation will be of 5000-K. W. capacity, with provisions for ultimately increasing it to 10,000 K. W. In the generating station will be located three 1500-K. W. and one 500-K. W., 3-phase, rotating-field, enclosed turbo-type generators, and three 300-K. W. rotary converters. Current will be generated at 375 volts, thus avoiding the necessity of step-down transformers for the main station rotaries. The outgoing lines will then be equipped with step-up transformers having a ratio of 375-33,000 volts. Each generator will be driven by a Westinghouse-Parsons steam-turbine and excited by a direct-current generator coupled to the end of the turbine shaft. Each sub-station will contain a 300-K. W. rotary converter supplied by three 33,000-375-volt step-down transformers. All transformers are of the oil-insulated self-cooling type. The contract also includes all necessary switchboards and protective devices for the control and protection of apparatus in the power house and rotary stations.

The Los Angeles, Cal., office of the Westinghouse Electric & Manufacturing Company, which has heretofore been in the Trust Building, has been removed to 527 South Main street.

A line of high grade generating sets of high efficiency and specially designed for isolated lighting service has been placed upon the market by the B. F. Sturtevant Company, of Boston, Mass. These sets have vertical cross-compound engines, and range in capacity from 17½ to 100 K. W. They are arranged to occupy little room and to operate under a maximum steam consumption from 41 to 31 pounds, respectively, per kilowatt-hour. They were originally designed to meet the rigid specifications of the United States Navy Department, where the maximum output for minimum weight and size was demanded. The economic results shown equal those obtained from sets of much greater power, and therefore render feasible the economical use of such comparatively small units.

Travelers between New York and Boston on the New Haven road will have their attention attracted as they pass through Bridgeport, Conn., by the large new signs of the Eaton, Cole & Burnham Co., manufacturers of brass and iron goods for steam, water, oil, and gas, on their two new plants in that city. On one plant they have just completed an immense sign over 1100 feet long, and at their other plant on the water front they have placed their name on their 100,000-gallon water tank, 130 feet in the air, which can be seen for miles around. Those who "ride and read" cannot fail to associate this active concern with the active industrial city of Bridgeport.

The New York City and Interborough Railway Company placed an order on July 7 with the J. G. Brill Company, of Philadelphia, for ten of its patented semi-convertible type cars, to be operated in the borough of Bronx and to connect with the cars of the subway system, which will soon be running through the lately completed tunnel under the Harlem River. The cars will measure 28 feet over the bodies, 38 feet over vestibules; width over sills 7 feet 11½ inches, and over posts at belt 8 feet; length of platforms 5 feet. The improved method of raising the sashes into pockets in the side roof, known as the "grooveless post" method, is called for in the specifications. The vestibule entrances will have Brill folding gates instead of doors. The cars are to be mounted on the builders' short-base double trucks. The Brill Company have furnished much of the rolling stock for the boroughs of Manhattan and Bronx, but these are the first cars of this type to be ordered for this system. It is noteworthy that the large number of orders recently placed for this type of semi-convertible include those of a number of the foremost systems in the country, including Boston, Philadelphia, Baltimore, Chicago and Montreal.

The New Allis-Chalmers Shops

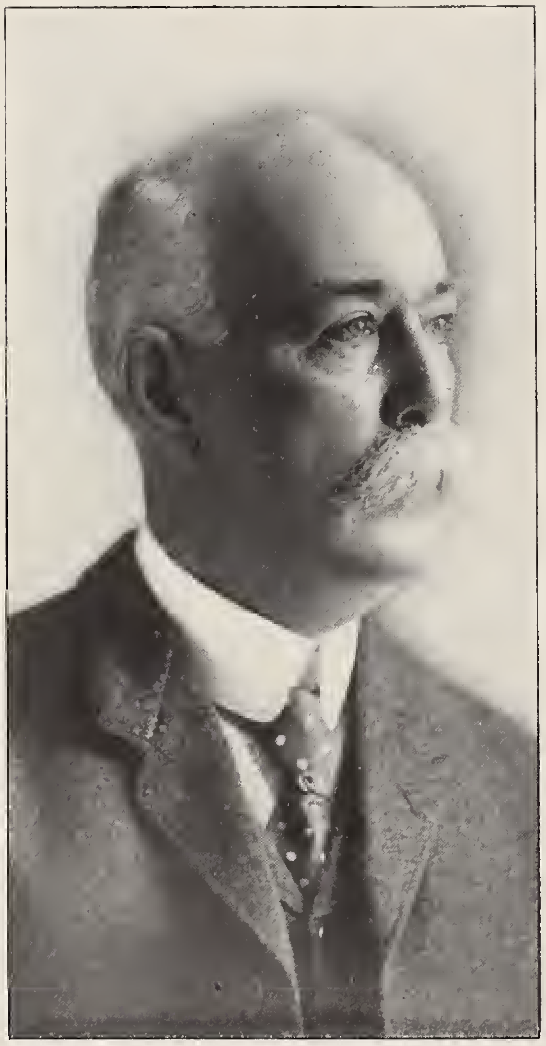
THE Allis-Chalmers Company have begun the great extensions to their already large works at West Allis, Milwaukee. They have awarded to James Stewart & Company, of Pittsburgh, the contract for acting as supervising engineers and managers of construction for the entire undertaking. The American Bridge Company, of New York, has secured the contract for the structural steel, erected in place, for three of the new buildings, a contract which calls for approximately 6800 tons of steel. The Riter-Conley Manufacturing Company, of Pittsburgh, has been awarded the contract for the structural steel, erected in place, for the foundry and pattern storage buildings and erecting shops, comprising approximately 4000 tons of steel. All the structural steel is to be delivered and erected within twenty-three weeks from the date of the signing of the contract. The company expects to occupy its

new works by or before next March.

Some idea of the size of the works, when extended, will be afforded by the fact that the company's present floor space at West Allis, Milwaukee, has a total area of 652,000 square feet, and the new extensions upon which work is now in progress will add 861,000 square feet, or will more than double the present capacity, making the total capacity at the West Allis works 1,513,000 square feet of floor space. The plant will be capable of affording employment for 11,000 persons; thus, in addition to the capacity of the other works of the Company in Milwaukee, Chicago, Cincinnati and Scranton, it will bring up the total number employed to the aggregate of 18,000 persons.

Personal

W. S. Heger, who has been closely associated for years with the Westinghouse interests, has joined the Allis-Chalmers Company as assistant to the vice-president and general manager. He received the degree of M. E. at Stevens Institute of Technology in 1879, and began his career in the draughting room of the Edgmoor Iron Works. In 1885 he went into business on his own account as a contractor and electrical engineer, and later became



W. S. HEGER

sole agent and constructor for the Edison Company for isolated lighting in Delaware, Maryland, the Virginias and the Carolinas. In 1889 he was district manager for the Pacific Coast territory for the Edison Company and the Edison United Manufacturing Company. Owing to the serious illness of a daughter, Mr. Heger gave up all business in the fall of 1890 and remained in retirement for two years. Resuming active work in 1892 he accepted the place of general manager of the Wilmington City Railway Company, Wilmington, Del., and spent three years there rebuilding and operating the road. Again returning to the Pacific Coast in 1895, he became the district manager for the Westinghouse Electric and Manufacturing Company with headquarters in San Francisco. He built up a strong selling organization and made a wide market for the products of his own company and those of the Sawyer-Man Company. At the beginning his territory covered the whole country from Alaska to Old Mexico, and reached east as far as Salt Lake City. As business was developed the territory was divided and district offices were opened at Seattle, Salt Lake City, Los Angeles and in British Columbia. Mr. Heger resigned his position with the Westinghouse Company in April. His headquarters are at the general offices of the Allis-Chalmers Company in Milwaukee.

Philip Torchio has now been made chief electrical engineer of the New York Edison Company, a promotion well deserved by conspicuous merit and ability. Mr. Torchio recently sailed for Italy to spend a vacation of several months.

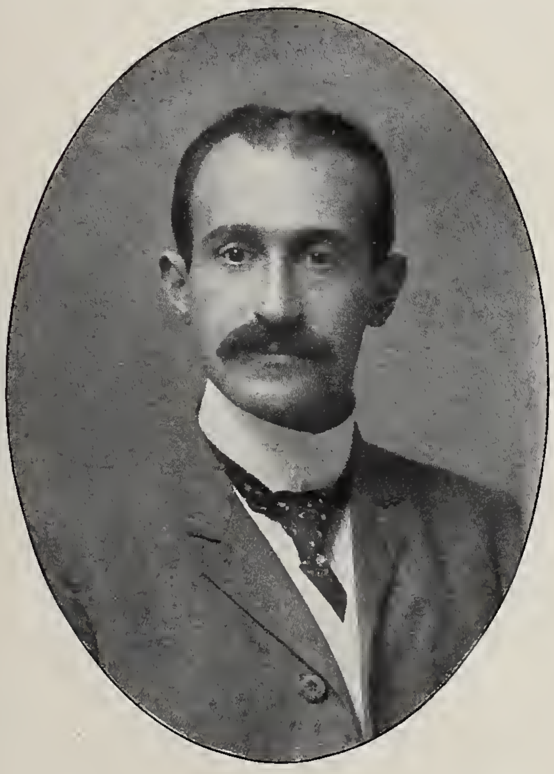
John Craig Hammond, who has been advertising manager of the Denver Gas & Electric Company, since the publicity matter of that company gained prominence in the gas and electric world, has organized the John Craig Hammond Advertising Company, of Denver. The general advertising field will be entered, but the company will make a specialty of gas and electric company publicity. Associated with Mr. Hammond are the men who have been on his advertising staff for more than a year, and a number of other men who have been working with him less directly, but along similar lines. A year has been spent by the members of the organization in perfecting their plans and their system. They have not only worked out their plans, but have tested them in every conceivable manner during the past

JOHN CRAIG HAMMOND

year, and they refer to the results for justification of their methods. It is the purpose of the company, says Mr. Hammond, to go farther than the mere designing of publicity matter for such companies as may become patrons. Included in his plan of operations are such features as the giving of suggestions on timely topics of general interest and importance, covering the relations of companies with the public and the general system of getting new business. The organizers of the new company believe that the joint effort of a number of companies in the same line of business, through the same organization, will accomplish what would be impossible to one company, operating alone. To a certain extent the plans for conducting these features of the business make them co-operative. The good work of the Denver company is well known. This work will be continued through the new company. The work of a number of other companies that have been receiving their publicity from the Denver offices will also be continued. A good general business, chiefly local, has been obtained, and the company begins operations with a prosperous outlook.

Max Loewenthal, of the Prometheus Electric Company, of New York, manufacturers of electric resistances and electric heating and cooking apparatus, has been elected vice-president of the New York Electrical Society. Mr. Loewenthal came to this country from Germany in 1887, at the age of thirteen years, and at once entered the Hebrew Technical Institute at New York, graduating from the electrical course

of that institution with honors in 1890. He then became the assistant of George A. Hamilton, chief electrician of the Western Electric Company, and in 1891 became the laboratory assistant of E. R. Knowles, of the Schuyler Electric Company, of Middletown, Conn., preparing himself, during his leisure hours and saving additional funds by teaching evenings, to enter Columbia University in 1893, winning a scholarship in that institution and being graduated with the degree of Electrical Engineer in 1897. In 1898 he joined the editorial staff of "The Electrical Engineer," and remained there until its consolidation with "The Electrical World." He then became associated with the late Max Osterberg in consulting electrical work, and in 1901 was one of the organizers of the Prometheus Electric Company, manufacturers of electric heating apparatus, of which company he is now secretary and electrical engineer. He was awarded a medal at the St. Louis Exposition for his contribution to the electrical heating industry. He prepared the electric heating chapter of "Foster's Handbook," and has been for a number of years instructor in mechanical drawing in various evening schools. He is also one of the lecturers for the New York Board of Education, and has been a frequent contributor to technical publications. Mr. Loewenthal is an associate member of the American Institute of Electrical Engineers and of the Pi Lambda Phi Fraternity of the New York Press Club.



MAX LOEWENTHAL

W. A. Stadelman, who has been in charge of the Eastern office of the Wellman-Seaver-Morgan Company, at 42 Broadway, New York City, has been appointed general sales agent of the company, with headquarters at Cleveland, Ohio, taking effect July 1. Fred Stadelman has been appointed assistant manager of the New York office of the company. The services have been acquired also of Harry V. Croll, M. E., for the past eight years with the E. P. Allis Company and their successors, the Allis-Chalmers Company, of Chicago.

L. M. Cargo, representing the Westinghouse Electric & Manufacturing Company at Denver, was one of those who helped to make the recent Denver convention of the National Electric Light Association the success that it was.

L. M. CARGO

George E. Heyl-Dia, who has established himself at 95 Liberty street, New York City, as a consulting expert on electric cable insulations, has devoted much attention to the manufacture of cable insulations, and was the inventor of an insulation called "Heylite," largely used in Germany by cable manufacturers. Following a call to England in 1889-90, he introduced there the well-known "Diatrine" insulations for electric cables, and later on accepted the position of managing engineer and chief chemist at Messrs. W. T. Glover & Co.'s works at Salford, Manchester, reconstructing their hydraulic lead covering department and superintending the making of rubber compounds generally. Mr. Heyl-Dia then founded the St. Helens Cable Company firm of Warrington & St. Helens, employing about 1000 men, and acted as chief engineer and managing director. He constructed the whole of this company's rubber and cable plant, introducing "Dialite," which is used in the mechanical rubber department, forming an important part of the company's business. After four years of strenuous work and responsibility, Mr. Heyl-Dia handed the management over to a newly appointed board, devoting himself principally to the scientific-practical branch of consulting engineering in connection with India-rubber, reclaimed rubbers and cables. He was also the originator of the "Dialine" Company, of Leyland, England, one of the most successful reclaiming works in England, which is now presided over by J. E. Baxter, of the Leyland & Birmingham Rubber Company. It may be added that Mr. Heyl-Dia has introduced with success valuable processes in the manufacture of rubber, utilizing some hitherto useless waste products, and has also demonstrated commercially a process for the improvement of the quality of reclaimed rubbers.

George Westinghouse is one of the new trustees of the Equitable Life Assurance Society, in company with ex-President Grover Cleveland.

G. M. Gest, of New York and Cincinnati, was recently awarded the contract for the construction of a complete underground conduit system for the Montreal Light, Heat & Power Company, of Montreal, Canada. Over a million feet of conduit are to be used in the construction.

Frank C. Randall has resigned the position of vice-president and general manager of the National Electric Company and joined the Allis-Chalmers Company as district manager for the district of New York, with headquarters in New York City. He has been closely identified for years with the street railway supply interests.

F. C. RANDALL

Herbert Laws Webb, the British telephone expert, was recently questioned by the Canadian legislative committee, now investigating the telephone business with a view to government control. He declared that government ownership of telephones was proving a failure, and that the Glasgow municipal system was partly obsolete.

Frank J. Sprague recently sailed for England and the Continent to be gone until the early fall. Heavy

electric traction problems will engage his attention on the other side.

T. A. Rickard, since 1903 editor of the "Engineering and Mining Journal," announces that he has resigned. Walter R. Ingalls succeeds him.

Ernst Wiener has severed his relations with the house of Arthur Koppel, with whom he has been connected for eighteen years, eight of which as manager of the New York office, and has opened offices at 68 Broad street, New York City, under the firm name of Ernst Wiener Company. The new company will make a specialty of railroads and railroad materials for all industries of both narrow and standard gauge. A special factory equipped with all modern machinery has been built in Youngstown, Ohio, for the purpose of exclusively building the specialties of the new firm, so it is in excellent condition to take care of all business. A large stock of rails, industrial track switches, cars, etc., will always be kept. Associated with Mr. Wiener in his new enterprise is Mr. Carl Koch, for many years chief engineer of Arthur Koppel, as well as the larger part of his former staff. The new company is ready for business.

Obituary

E. A. Leslie, general manager of the Kings County Electric Light & Power Company, Brooklyn, N. Y., died on June 5 from pneumonia.

Among the victims of the recent disastrous wreck of the Twentieth Century Limited train on the Lake Shore Railroad at Mentor, Ohio, Charles H. Wellman and T. R. Morgan of the Wellman-Seaver-Morgan Company, of Cleveland, Ohio; A. P. Head, director of the Otis Steel Company, Cleveland, Ohio, and member of the firm of Jeremiah Head & Son, London, England. Mr. Wellman was born June 12, 1865, at Nashua, N. H. In 1896, with S. T. Wellman, who is now president of the Wellman-Seaver-Morgan Company, and with John W. Seaver, now chairman of the same organization, he organized the Wellman-Seaver Engineering Company, becoming engineer and general manager of the company. At the time of his death he was general manager of the Wellman-Seaver-Morgan Company. He is survived by his widow and three children.

Mr. Morgan was born in 1859 in South Wales. His father organized the Pittsburgh Steam Hammer Works, and later removed to Alliance, Ohio, engaging in the business which later became the Morgan Engineering Company. In 1897, on the death of his father, he disposed of his interests in and severed his connection with the company, and later engaged with the Wellman-Seaver Engineering Company. In 1902, in recognition of his services and ability, the name of the company was changed to the Wellman-Seaver-Morgan Engineering Company, of which he was at that time secretary and works manager. On consolidation with the Webster, Camp & Lane Company, Akron, Ohio, the company name was changed to the present title, the Wellman-Seaver-Morgan Company, Mr. Morgan being second vice-president and works manager at the time of his death. He also leaves a widow and three children.

Mr. Head, in 1890, became assistant to his father, Jeremiah Head, consulting engineer, and in 1894 became his partner, moving the office from Middlesborough to London, under the style of Jeremiah Head & Son. Jeremiah Head died in 1899, and in 1904 another son, Benjamin W. Head, was taken into partnership, the style of the firm remaining unchanged. Since 1899 A. P. Head acted as joint managing director of the Otis Steel Company, Ltd., of Cleveland, Ohio.

New Catalogues

A new "Lifting Magnet" bulletin has just been issued by the Electric Controller & Supply Company, of Cleveland, Ohio, who, during the past few years have developed the lifting magnet business in this country to a very notable degree. The new modestly termed "bulletin" is in reality a very attractively printed catalogue with an artistic cover, and contains a large number of interesting illustrations of magnets lifting all kinds of metal loads,—pig iron, scrap iron and steel, iron and steel castings, rail ends, billets, ingots, and plates of various dimensions. A particularly novel use for the lifting magnet is that in connection with skull-cracker work, of which, by the way, mention is made elsewhere in this issue. In the concluding pages of the catalogue the company presents sketches and particulars of methods of wiring a lifting magnet from a crane cage. This is an important matter, as probably very many possible users have been deterred from employing lifting magnets on account of the supposed difficulty of taking care of the slack wire necessary to provide for the operation of the crane. On the last page of the catalogue, particulars are given of the information required by the company in order to furnish a lifting magnet for a certain apparatus, and insure its success. A large number of these magnets are now in successful operation and promise to have a growing range of usefulness.

An attractive pamphlet recently issued by the Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., illustrates and describes the company's exhibits at the Lewis and Clark Exposition at Portland, Oregon. Other illustrations are given of power house and railway equipments and motors applied to a variety of work. Another pamphlet sent out deals with single-phase integrating wattmeters for two and three-wire circuits. Illustrations of the meter are given, each detail being briefly described.

Alternating-current motors built by the Wagner Electric Manufacturing Company, of St. Louis, are illustrated and described in a folder recently sent out. Four types are illustrated—a single-phase, constant-speed motor; a single-phase motor for elevator, hoist and variable-speed work; a "squirrel-cage" polyphase motor, and an external resistance, polyphase motor.

Screens for coal, ore, sand, etc., made by the Jeffrey Manufacturing Company, of Columbus, Ohio, are illustrated in a catalogue recently issued by them. A wide variety is shown. Cylinder dryers, operated with heat from a furnace, or by steam in pipe coils, are also illustrated. A folder also illustrates coal-handling machinery and equipment.

Koerting gas engines, built by the De La Vergne Machine Company, of New York, are illustrated and described in a new catalogue issued by them. Data taken from a paper on "The Blast Furnace as a Power Plant," by E. A. Uehling, are given to show the availability of blast furnace gas for use in this engine. A number of tables also are given of tests of producer gas, of comparative tests of steam and gas plants, of characteristics of power gases, of thermal and chemical data of combustion, and of calorific value of elementary gases.

Switchboard panels for single-phase circuits are illustrated and described in a bulletin recently issued by the Fort Wayne Electric Works, Fort Wayne, Ind. The "Wood" voltmeters and ammeters, fuse blocks, switches, illuminating lamps and po-

tential transformers, forming the panel equipment, are also dealt with. Wiring diagrams, too, are given. Another bulletin is devoted to induction integrating wattmeters, while prepayment wattmeters of two different types are each dealt with in a separate bulletin. Still another bulletin deals with high-torque, single-phase wattmeters. An attractive pamphlet, entitled "Notes on Prepayment Wattmeters," sets forth the advantages of this type. Another pamphlet contains instructions for the installation, adjustment and care of multiphase induction integrating wattmeters. Wiring diagrams are given for a variety of service.

A bulletin issued by the Knowles Steam Pump Works, of New York, illustrates and describes a motor-driven reciprocating pump. A separate folder illustrates and describes motor-driven, vertical, duplex, mine-sinking pumps, steam-driven plunger and bucket and plunger pumps, a suction condenser for sinking pumps, and a telescopic extension joint.

A catalogue recently issued by the Schaeffer & Budenberg Manufacturing Company, of New York, deals with a large variety of steam engine and boiler appliances, automobile specialties, and brewery and distilling supplies. The list includes steam, air, water and vacuum gauges, recording gauges and indicators, gauge frames, hydraulic and other forms of gauge-testing apparatus, mercury gauges, draught gauges, anemometers, hydrometers, thermometers, water columns, safety valves, whistles, injectors, traps, indicators, tachometers, lubricators, lead-lined valves and depth gauges.

Manila rope, its manufacture, uses and properties are illustrated and described in a catalogue recently issued by the C. W. Hunt Company, of West New Brighton, Staten Island, N. Y. Illustrations show rope-making as depicted in Egyptian sculpture, and the method used in the Plymouth Cordage Works in 1893. Rope transmission is also shown in Egyptian sculpture and as used in a modern plant. A number of diagrams show different ways of using rope for power transmission, and the splicing of rope is also illustrated and described. A number of tables are given of working loads for various diameters of rope and sheave.

Field rheostats for 125, 250 and 500-volt circuits are dealt with in a bulletin recently issued by the General Electric Company, of Schenectady, N. Y. Five types are illustrated, diagrams giving the dimensions and capacities of each. Circuit breakers for 250 and 650-volt, direct-current circuits are illustrated and described in another bulletin. A third bulletin deals with mercury-arc rectifier outfits. Besides that of 20 or 30-ampere capacity, one of 5 to 15-ampere capacity for dental service is also shown. Concentric diffusers and adopters for arc lamps are illustrated and described in a flyer, railway motor repair parts are listed in a pamphlet, and a price list gives the cost of a variety of fan motors for direct or alternating-current service.

Storage batteries for use in the ignition of automobile gasoline engines are illustrated in a circular recently sent out by the National Battery Company, of Buffalo, N. Y. These cells are put up in either wooden or metal cases, the jars containing the elements being made of transparent celluloid. The circular gives the dimensions and price of the various sizes. In another circular the company announces that they are agents for Studebaker electric vehicles. A third circular deals with the future of storage batteries, outlining the many uses to which they may be put.

The American Electric & Controller Company, of New York, is sending out in pamphlet form an illustrated description of a new alternating-current controlling apparatus. Illustrations are given of the controller with diagram of connections, and of a system embodying typical applications of the device.

As an interesting and useful advertising monthly the American Engine Company, of Bound Brook, N. J., is sending out a well-engraved and printed coloured map of the United States.

A. L. Ide & Sons, of Springfield, Ill., with branch offices in New York and Philadelphia, have sent out a booklet which, as they say, is devoted to "ideals,"—ideals in steam power plant practice. As the most important factor in the power plant is the engine, the booklet very naturally concerns itself primarily with the Ideal engine, which is illustrated and described in more or less detail.

A catalogue recently sent out by the Northern Engineering Works, of Detroit, Mich., illustrates and describes a wide variety of cranes. The list includes electric traveling cranes for direct and alternating-current service, transfer tables, trolley hoists and overhead track system, all electrically operated. Electric chain hoists are also illustrated, as well as those operated by air and by hand. Jib and pillar cranes operated by electricity, air or hand are also dealt with, and steam and electric locomotive cranes are illustrated.

The Stanley Instrument Company, of Great Barrington, Mass., have issued a circular bearing the date June 20, 1905, and announcing that on and after June 21 they will fill all orders in hand or received thereafter with their rotated jewel bearing wattmeters which counsel of eminent standing have declared to be outside of any valid claim of infringement of Tesla patents.

The Carnegie Schools Open in October

ANNOUNCEMENT is made that the first department of the Carnegie technical schools at Pittsburgh, Pa., will open next October. The department will be known as the School of Applied Science, and there will be day and night courses, providing instruction in those studies essential to a technical education.

Applicants for admision to the school must be at least sixteen years old. They will be required to pass an examination in English, mathematics, science and drawing. Certificates from approved schools of high school or preparatory grade will be accepted from students without an entrance examination, but no student will be admitted who does not give evidence of a natural aptitude for technical work.

Residents of Pittsburgh will be required to pay a tuition fee of $20 a year and all other students $30 a year. The examinations for entrance will be held in Pittsburgh during the week of October 9.

Applications have already been received from 7200 persons throughout the world who are desirous of enrolling themselves as pupils at the institute. Every country in the civilized world is represented by those after learning, and most of them are men who have already reached their majorities and who desire to come to America and learn American methods of doing business. The number of applications from France and Germany exceeds those of any other country, while there is a goodly showing from Japan and Russia and a few from China. The Philippines have sent in many applications. On account of the enormous number of applications it has been decided to re-

ceive pupils from Pittsburgh and Allegheny first, then the State of Pennsylvania and the other States of the Union, leaving the foreign countries until the last.

German Regulations for High-Tension Overhead Wires

THE regulations of the Verband Deutscher Elektrotechniker, as amended last year, include a number of rules for high-tension overhead wires and cables, the chief points in which are here given:—

All installations come within the range of the high-tension regulations, if the effective pressure between any conductor and earth is (or may be through an earth) more than 250 volts.

Overhead wires must be bare, but where they are exposed to detrimental chemical action they may be provided with a coating of protective paint.

The insulation of overhead wires in damp weather must not be less than 80 ohms per volt and kilometer (128 ohms per volt and mile) but need not exceed 1,500,000 ohms. Generating plants are to be provided with means for measuring the insulation resistance during actual service.

Overhead wires must have a cross-section of not less than 10 sq. mm. (0.0155 square inch.)

The insulators must be of porcelain, glass or an equivalent material, and, when used for voltages above 2000 volts, they are to be tested at the factory to at least double the working voltage. The insulators are to be used in an upright position only.

Earth connections are to be soldered, the only exception being when earthing switches are used, in which case the connections may be screwed to the switch and the object to be earthed. Wire netting, perforated or unperforated metal sheets, or similar materials are to be used as earth plates, and pipework may form part of the earth connection, but must be supplemented by such earth plates.

Supports and guarding devices of overhead conductors, the voltage of which to earth exceeds 500 volts, must be marked by a red zig-zag.

Overhead wires must be at least 6 metres (20 feet) above the ground in ordinary positions, and at least 7 metres (23 feet) when crossing highways. The span and sag of overhead wires are to be such that the factor of safety against breaking is 10 in the case of wooden poles, and 5 in the case of iron structures. At—20 degrees C. (—4 degrees F.) the tensile stress in the overhead conductors must not be more than one-fifth (or one-third in the case of hard-drawn metal) of the breaking stress.

Overhead wires and apparatus must be inaccessible without special means.

In inhabited places the overhead wires must be provided with section switches which may be operated during actual service.

In inhabited places and grounds and in the proximity of roads, where falling wires might endanger life, the wires are either to be placed so high that, upon breakage, the wire ends hang not less than 3 metres (10 feet) above the ground, or the falling of the wires must be prevented by guards, or means must be provided for causing the fallen parts to become "dead." Provision is to be made at corners of the transmission line for preventing the wires from dropping should the insulators break.

Where the pressure exceeds 1000 volts, the anchor wires are to be fixed to the poles with the interposition of an insulator, and the point of attachment to the pole must not be less than 3 metres (10 feet) above ground.

Platinum Resources of the United States

THE United States Geological Survey is to make an examination of heavy sands collected from all placer mines in the United States where preliminary tests have shown the presence of platinum. For this purpose owners of placer deposits are requested to mail to the Washington office not more than 4 pounds of material.

It is suggested that the gravel be concentrated as well as possible before mailing, care being taken not to lose any heavy material. There should be noted on the package, or in a letter accompanying it, or both, the total quantity of original gravel which the concentrate represents, in order that a general idea may be obtained of the value of the gravel for the purposes under investigation.

Each package of sand should be accompanied by exact information as to the name and postoffice address of the sender, the name of the mine or claim from which it came, and the State, county, city, village or district in which the deposit is located. On request, postal franks will be sent to owners of deposits in order that sand may be shipped without expense.

After an examination of these preliminary samples, experts will be sent to all localities where preliminary tests give promise of platinum in profitable quantity. The expert will report on the size of the deposit and superintend the collection of representative samples for concentration.

Among the now-known sources of platinum are California, Oregon, Idaho, Montana, New York, North Carolina, Georgia, Pennsylvania, Wyoming and Alaska, in the United States, and Canada, Mexico, Central America, the West Indies and South America.

Carbon-Tube Electric Furnaces

IN a recent paper before the Faraday Society of Great Britain, R. S. Hutton and W. H. Patterson said that the carbon-tube electric furnace seemed to be the most readily available for the very highest temperatures, and they had been able to get satisfactory results with a very simple type of construction. The important points to bear in mind are the end connections, which must be kept cool, protection of the tube from contact with air, and heat insulation. Two types of furnace were described. The graphite tube furnace is bored from a solid rod of Acheson graphite and screwed into graphite plates which form the end connections, the latter being clamped to copper holders. The central thinner portion of the tube is surrounded with carborundum or other heat insulator, and the material to be heated is placed in small carbon boats. In a tube of 0.59 inch internal diameter, 320 amperes at 96 volts melt platinum in 16½ minutes.

The agglomerated carbon-tube furnaces are more suitable than the former type when much experimental work has to be done, and the tubes can be readily obtained. The ends of the tubes, which are too hard to be worked, are coppered electrolytically and soldered to copper tube extensions, provided with water-jackets to keep the joint cool. Into these the current is led by copper clamps, and glass tubes for the passage of gases, etc., are connected by means of rubber stoppers. Carborundum kept in place with an external asbestos tube serves as the jacketing material, as before. Tube furnaces up to 2.6 inches in internal diameter have been successfully made. It is hoped to use these in a vertical position, so that large crucibles may thereby be heated. In such a tube 850 amperes at 13 volts melt nickel in 12 minutes and platinum in 20½ minutes.

In a special tube furnace for experiments in atmospheres of pure gases—free from carbon monoxide—the furnace proper is surrounded by an outer jacketed carbon tube, also provided with water-cooled copper extensions, and the joint between the two is gas-tight. Hydrogen is passed through the space between the tubes.

Long-Distance High-Tension Transmission in California

By JOHN A. BRITTON, General Manager of the California Gas and Electric Corporation, San Francisco

A Paper Read Before the National Electric Light Association at its Denver Meeting Last Month

FIG. 1.—HAULING THE UPPER PART OF AN ARMATURE OF A 5000-KW. GENERATOR TO ONE OF THE MOUNTAIN POWER HOUSES

THE State of California is entitled to the credit for initial, original and pioneer work in long-distance electrical transmission, not only in the actual operative length of lines, but also in the high pressures used in such transmission. The progress made by the financiers and engineers in this State during the past ten years has been so phenomenal as to attract world-wide attention, with the result that there is a constant stream of those interested, from all parts of the world, to the Coast to observe the original work being done. Not only is California concerned in its trials and triumphs in long-distance transmission, but it has been the pioneer in high-head hydraulic work as developed for large units. A recitation of the developments of electric transmission in the State would occupy more time than your patience would admit of, but a brief résumé of what has been accomplished in the past ten years, all now under the control of the California Gas and Electric Corporation, may not prove an uninteresting one.

In the year 1888, attention in the engineering world was attracted by the Folsom Water Power Company determining to build a dam across the American River, near the town of Folsom, and to erect a power house some two and one-half miles south of the dam on the river, conveying water by a canal having a capacity of 40,000 miners' inches, to low-head turbine wheels, under a head of 65 feet. Four 750-K. W. units were installed, generating current at 800 volts, stepping up to 10,000 volts, and conveying the current thus generated to the city of Sacramento, 22 miles distant. The promoters of this enterprise were discouraged by the inability of engineers at that time to guarantee that 10,000 volts could be safely carried that distance for commercial purposes. In 1895 this dream became a reality, and Sacramento City was supplied with current generated at Folsom. While the insulation provided gave more or less trouble initially, this was gradually overcome.

In 1892 the late A. W. Decker, electrical engineer, acting for the San Antonio Light & Power Company, at Pomona, Cal., recommended the installation of electric equipment at the power plant of that company, to convey by means of step-up transformers a pressure of 10,000 volts

FIG. 2.—CORNER POLE TOPS WITH GUARDS TO PREVENT WIRES FROM FALLING IF PULLED OVER

over approximately 16 miles of line, to the city of Pomona. The generators as finally installed delivered single-phase current at a pressure of 500 volts, and the transformers were wound in the ratio of one to two. There were ten transformers in service on the primary, giving 10,000 volts with a capacity of 6 K. W. each. Glass insulators were used upon this line.

In 1895 there was begun the construction of a water-power plant near Nevada City, Nevada County, in the State of California, to transmit about 1000 H. P. a distance of five miles, with generators wound direct for 5000 volts. The water was conveyed from a dam on the South Yuba River through three and one-half miles of flume, having a capacity of 8500 cubic feet per minute, and delivered to a 42-inch pipe, 286 feet long, with a head of 190 feet. There were installed at that time two 330-K. W. units.

From these small beginnings has grown a system throughout the State aggregating in generator capacity at present installed over 50,000 K. W., with units of 5000 K. W. and varying heads up to 1530 feet. In the central part of the State, utilizing the waters of the western slope of the Sierra Nevada Mountains, there are at the present time, in continuous operation, 577 miles of ditches, 25.5 miles of flumes, operating 14 water-power plants, having installed 41 generators, with a rated capacity of 50,790 K. W., and having a water storage in numerous lakes aggregating over 3000 million cubic feet, or 1,500,000 miners' inches for 24 hours. From these power houses there are in continuous service 715 miles of pole line and 734 miles of circuit operated at 50,000 to 60,000 volts, 479 miles of circuit at voltages varying from 10,000 to 50,000, and 90 miles at lesser voltages, not including any local distribution. Power is delivered to 94 sub-stations, with 75,000 K. W. in transformer capacity, scattered over 21 counties and 33 cities in the State, representing a population of over 60 per cent. of the entire State of California, and covering an area of 15,000 square miles. This power is regularly transmitted 232 miles, and, by reason of certain conditions at times existing at the different power plants necessitating the transmission over all lines from one power plant, the power has been successfully transmitted 325 miles at 55,000 volts.

In addition to the transmission of power, it may be interesting to know that the high-pressure wires supply 1961 miles of distribution wires in service, with 2300 to 5000 volts, and serve approxi-

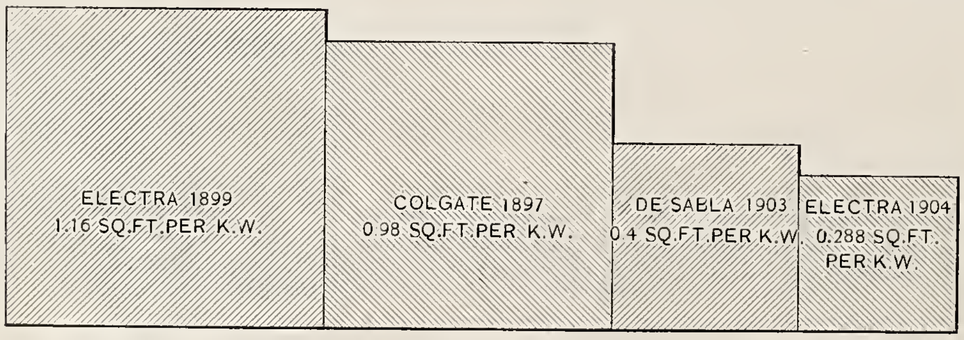
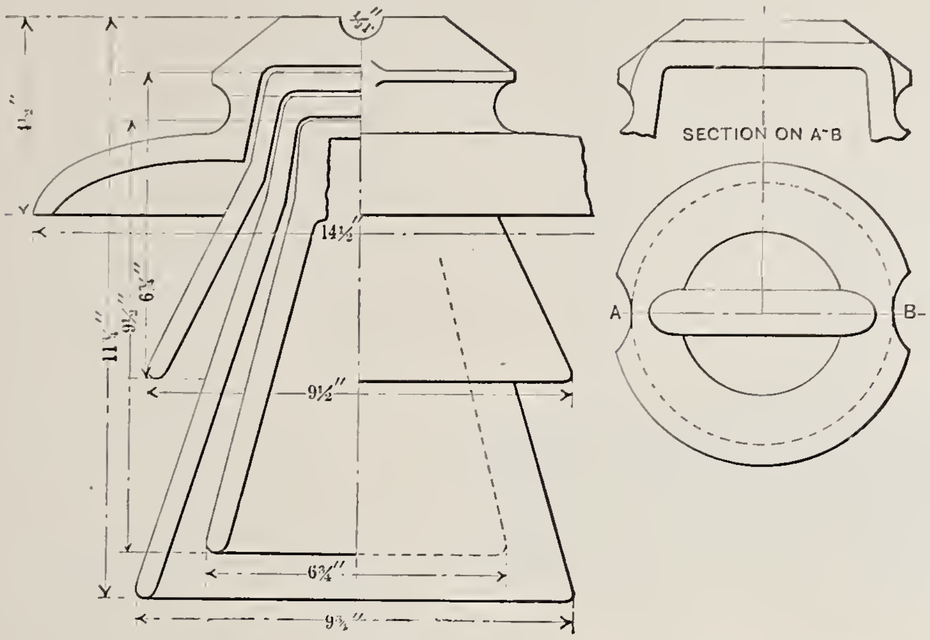


FIG. 3.—POWER HOUSE AREAS, SHOWING THE CONTRACTION RESULTING FROM THE INSTALLATION OF LARGE UNITS

FIG. 4.—CABLES CROSSING THE STRAITS OF CARQUINEZ, CALIFORNIA, USED IN POWER TRANSMISSION BY THE BAY COUNTIES POWER COMPANY. THE DISTANCE BETWEEN THE TOWERS IS 4427 FEET, MAKING THE CABLE SPAN THE LONGEST IN THE WORLD. THE CABLES WERE SUPPLIED BY THE JOHN A. ROEBLING'S SONS COMPANY, OF TRENTON, N. J.

mately 20,000 consumers for lighting and motors of 100 H. P. and less, amounting altogether to 40,000 H. P.



FIGS. 5 AND 6.—ONE OF THE 60,000-VOLT, FOUR-PART INSULATORS

Avoidance will be made here of unnecessary details of power-house operation, or of the operation of the hydraulic systems in connection therewith, and, except as it may be necessary to illustrate a point made, this paper will be concerned solely with the transmission lines.

In no other portion of the globe, where long-distance transmission under extreme high potential has been used, do climatic conditions exist similar to those in California, and this must be particularly borne in mind when considering the work that has been done, the problems solved, and the successful conclusions arrived at in the determination that there is no limit, except that of the earning capacity on capital, to the carrying of current over wires to any distance.

As previously stated, power is obtained from the waters flowing from the western slope of the Sierra Nevada Mountains. These mountains are snow-capped the year round, and some of the power houses are within the snow belt which exists during the winter season. Following down the mountain sides, the pole lines emerge into the vast Sacramento and San Joaquin valleys, which extend from Sierra County on the north to Kern County on the south, a distance of approximately 350 miles, and average about 60 miles in width. After leaving the valleys, the pole lines cross the Coast range, lying between the valleys and the Pacific Ocean, and generally follow the contour of the bays of San Francisco, San Pablo and Suisun, until they reach the commercial centers of distribution. In this long distance traversed, they are subjected to extreme climatic conditions,—from the colds and frosts of the mountains to the severe heat of the valleys, and to the cooling fog-laden winds from the ocean.

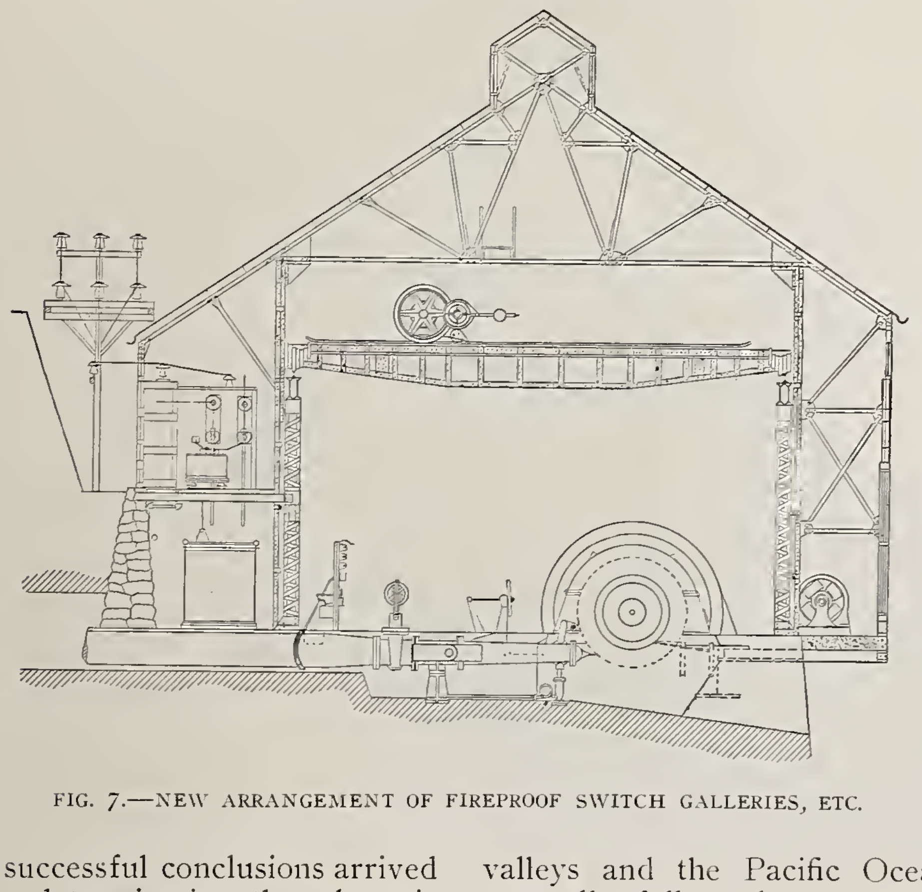


FIG. 7.—NEW ARRANGEMENT OF FIREPROOF SWITCH GALLERIES, ETC.

The first transmission line to reach the bay shore was that of the Bay

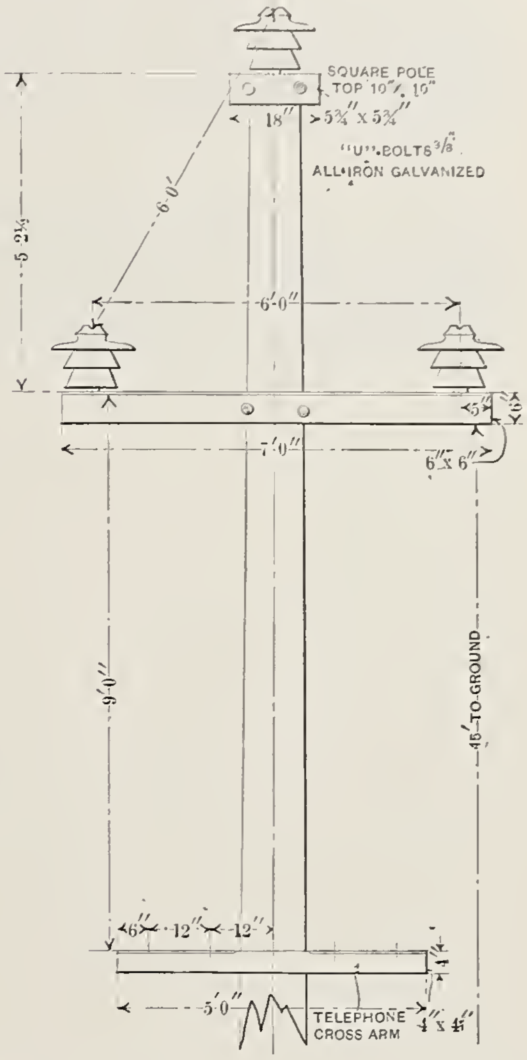


FIG. 8.—PRESENT METHOD OF CONSTRUCTING POLE TOPS FOR 60,000 VOLTS

Counties Power Company, carrying current generated at Colgate on the Yuba River, about 28 miles northeast of the City of Marysville. This line was started at 44,000 volts, which voltage has since been raised to 55,000. The construction of the line was of round cedar poles, from the State of Oregon, having an average height of 50 feet, and the character of construction substantially that now in use, but with a less separation in some instances than was subsequently found necessary. The very many alterations of plans from time to time, as different conditions required, to insure service, need not be here recapitulated, the details being confined to the present method of construction. The greatest difficulty encountered in the carrying of the high potential was in and about the bays mentioned, due to the heavy salt fogs that for certain periods of the year hang densely over the land, some-

FIG. 9.—THE 10,000-VOLT LINE FROM THE FOLSOM POWER HOUSE. OLD CONSTRUCTION

times lasting for days. In these particular districts, the insulation has broken down at most unexpected places, causing the burning off of poles and the shortening of the line.

The new four-part insulator illustrated in Figs. 5 and 6, with iron pins, has entirely overcome this defect, and for the past season, under the most trying circumstances, no trouble has occurred, the number of hours of shutdowns upon all of these lines being of a negligible quantity.

In addition to the conditions described of transmission over and through countries of varying temperatures, it must be remembered that for seven months of the year, extending usually from April until the first of November, no rain falls within the district named, and where the pole lines run along or adjacent to the public highways, where heavy teaming for all purposes is carried on, they are covered with a fine dust, which arises from traffic, and are subjected at times to extremely hot north winds. For the remaining five months of the year the lines are subjected from time to time to heavy rains and to the high winds accompanying the winter storms. Bearing all these facts in mind, it is nothing short of remarkable that within a period of not over four years such wonderful results have been obtained in transmitting current over the distances involved, for the establishment of the Colgate plant and the carrying of current into the City of Oakland, its initial distributing point, occurred in the year of 1901.

One of the greatest engineering feats ever accomplished, and one that has never received from the engineering world the attention which it deserves, was the construction, in 1901, of the famous Carquinez span of four steel cables, suspended from steel towers as shown in Fig. 4. This span crosses the Carquinez Straits, connecting San Pablo and Suisun bays, and is 4427 feet in length between towers, having at its maximum point of dip an elevation of 206 feet above high-water line. The maximum sag of the wire between the two steel towers on the north and south sides of the straits is 257 feet. The main tower, in Solano County, on the north side of the straits, is 224 feet in height, and the bluff at the point of construction is 162 feet above tide water; on the south side the tower is 64 feet in height, and the bluff is 400 feet above tide water. It is interesting to note that this crossing has given absolutely no trouble in operation. Both of the towers mentioned are used for distributing stations to the different manufacturing cities along the bay shore, besides serving as general switching stations.

In the ordinary construction, spans up to 1800 feet in length are constructed in the mountains across deep ravines, using ordinary 40-foot round cedar poles for the purpose. A good sample of this work is shown in Fig. 10, in connection with the spans from the de Sabla plant to the Valley Counties Power Company, in Butte County.

Experience has demonstrated that the form of lightning arrester which gives good service at low voltage is

FIG. 10.—AN OUTDOOR DISCONNECTING SWITCH

absolutely useless on high-tension lines. While these were first installed, they have since in every case been abandoned. At the present time nothing is used but the horn gap arrester. As the voltage of the lines

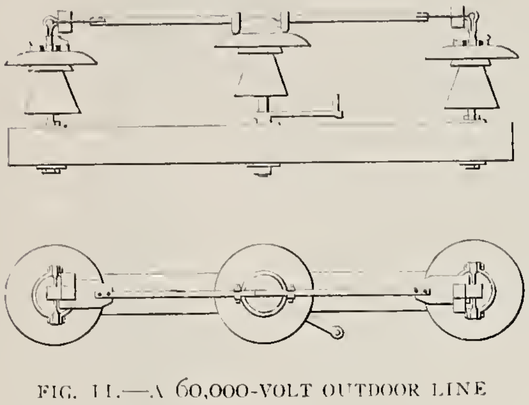


FIG. 11.—A 60,000-VOLT OUTDOOR LINE SWITCH

has been raised and the insulation increased, the damage due to lightning is steadily decreasing. It is well to state that beyond the line of the foot-hills of the Sierra Nevada Mountains, lightning rarely occurs, possibly once a year throughout the Sacramento and San Joaquin valleys and along the bay shore are there any discharges of lightning that would be detrimental to the lines.

The first construction of lines in this State was 40 to 50 poles to the mile, insulators being used at a maximum cost of 15 cents. All new lines are now being constructed on the basis of 20 poles to the mile, and the four-part insulators illustrated in Figs. 5 and 6 are being used, costing approximately $2 each, and weighing about thirty pounds. These are the outcome of months of patient work and experiment by the engineers on the Pacific coast. Fig. 8 shows the general construction of the pole top for 60,000 volts. Fig. 9 shows the transmission line from the Folsom plant, heretofore mentioned, operating to-day, as when it started, with four circuits at 10,000 volts at over 18 per cent. loss. These circuits are now being changed to operate at 60,000 volts, and with the type of construction shown in Fig. 8 the loss in the 22 miles of transmission at 60,000 volts, with only one circuit, will be about 2 per cent. Fig. 2 illustrates the method of construction at corners, giving a view of the insulated guards attached to the outward insulators to prevent wires from falling to the ground if pulled over This has proved effective in more than one instance. The construction shown is at the top of a 60-foot round cedar pole. Attention is particularly called to the very strong methods adopted in both cross-arm work and braces.

Much work has been done in designing and carrying out the construction of outdoor switches, as shown in Fig. 11, and Figs. 10 and 14 show these switches in place, arranged for three-pole remote-control operation. Experiments have been continuous along the lines of oil switches, and experience has demonstrated sufficiently that this switch as at present constructed is entirely satisfactory and will handle heavy currents under high pressures. Double-break and quadruple-

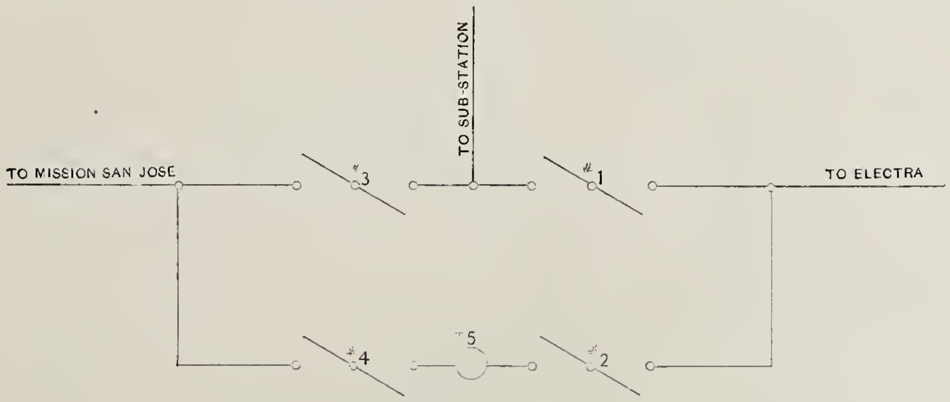


FIG. 12.—DISCONNECTING SWITCHES

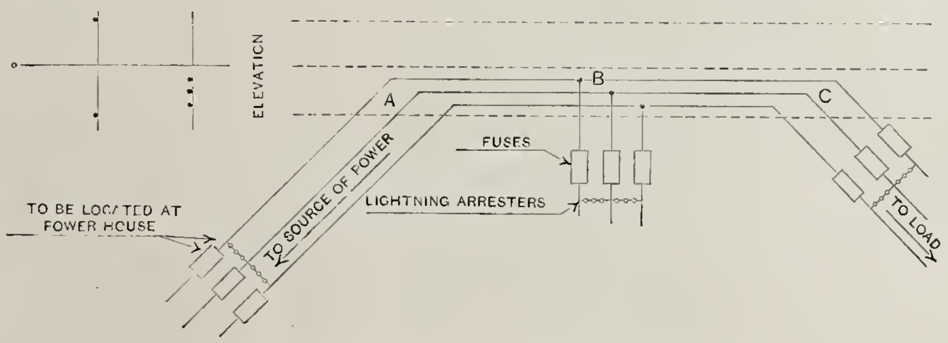


FIG. 13.—PROTECTION OF DISTRIBUTING LINES

FIG. 14.—OUTDOOR SWITCHES

break oil switches are now being made, the latter being used for very heavy service in the large power houses. Fig. 17 shows one form of oil switch, and also shows the method of constructing fireproof switch galleries, the construction of which, so far as the writer is advised, is entirely original with the Pacific Coast. The switching is done by opening the three legs at the same time, the single-pole arrangement having been found to be extremely unsatisfactory for obvious reasons. Fig. 18 illustrates a switch for disconnecting a bank of transformers from the bus-bars, and Fig. 7 illustrates the present method of construction not only of the fireproof switch galleries, but of a power house, showing locations of waterwheel, generator, exciter and switchboard. Figs. 12 and 15 illustrate the present method of switching arrange-

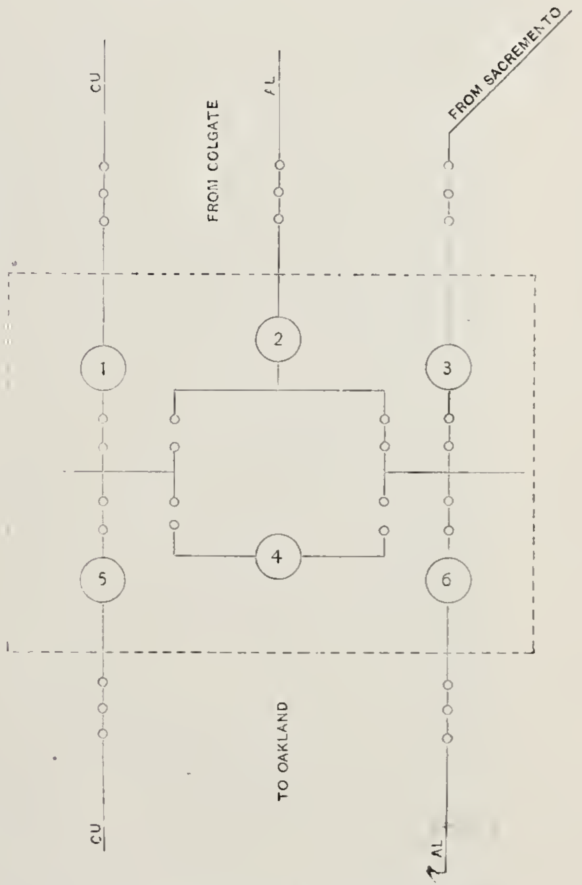


FIG. 15.—DISCONNECTING SWITCHES

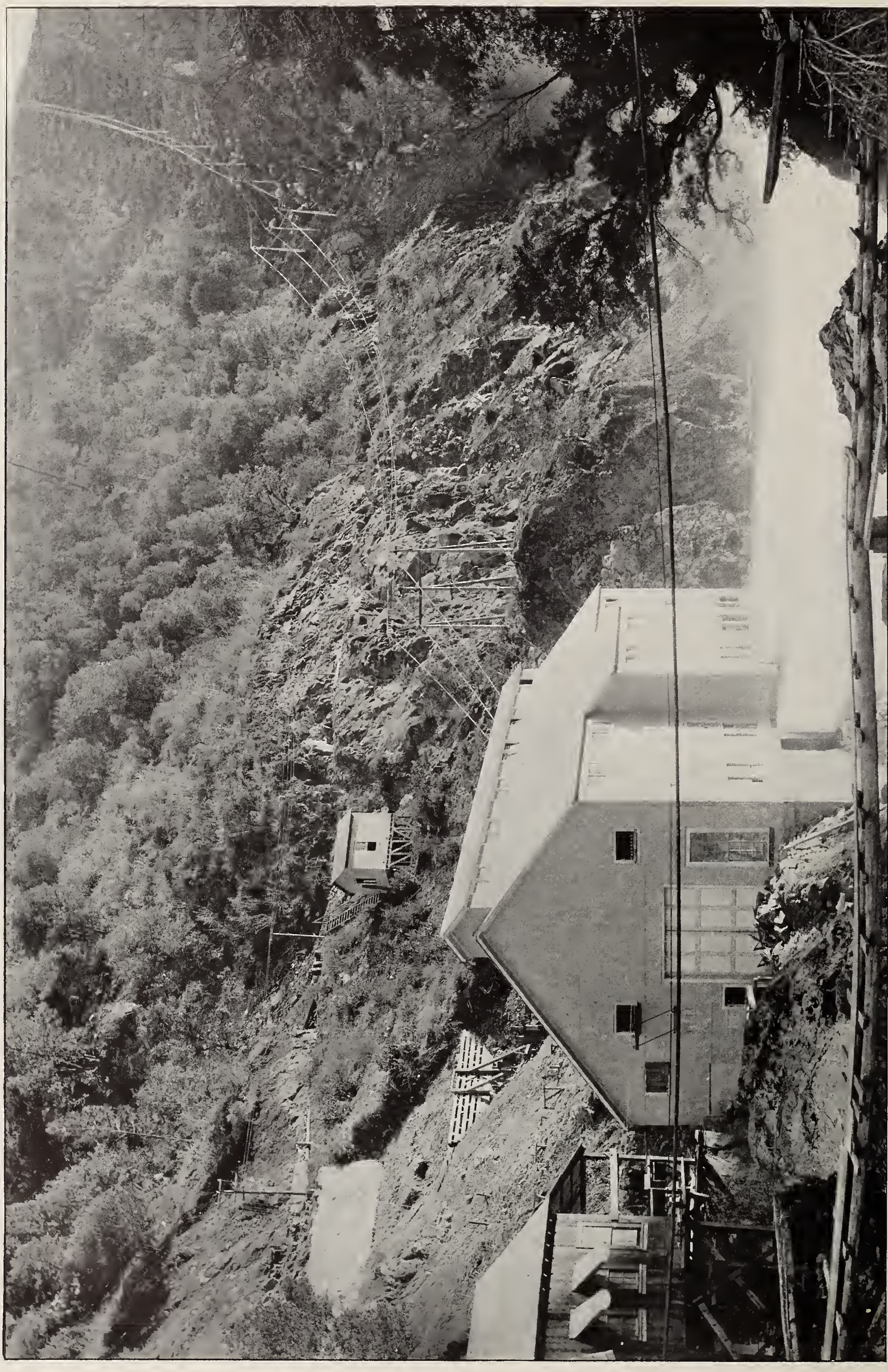


FIG. 16.—THE DE SABLA POWER HOUSE, SHOWING LONG SPANS ON 40-FOOT POLES CROSSING RAVINES

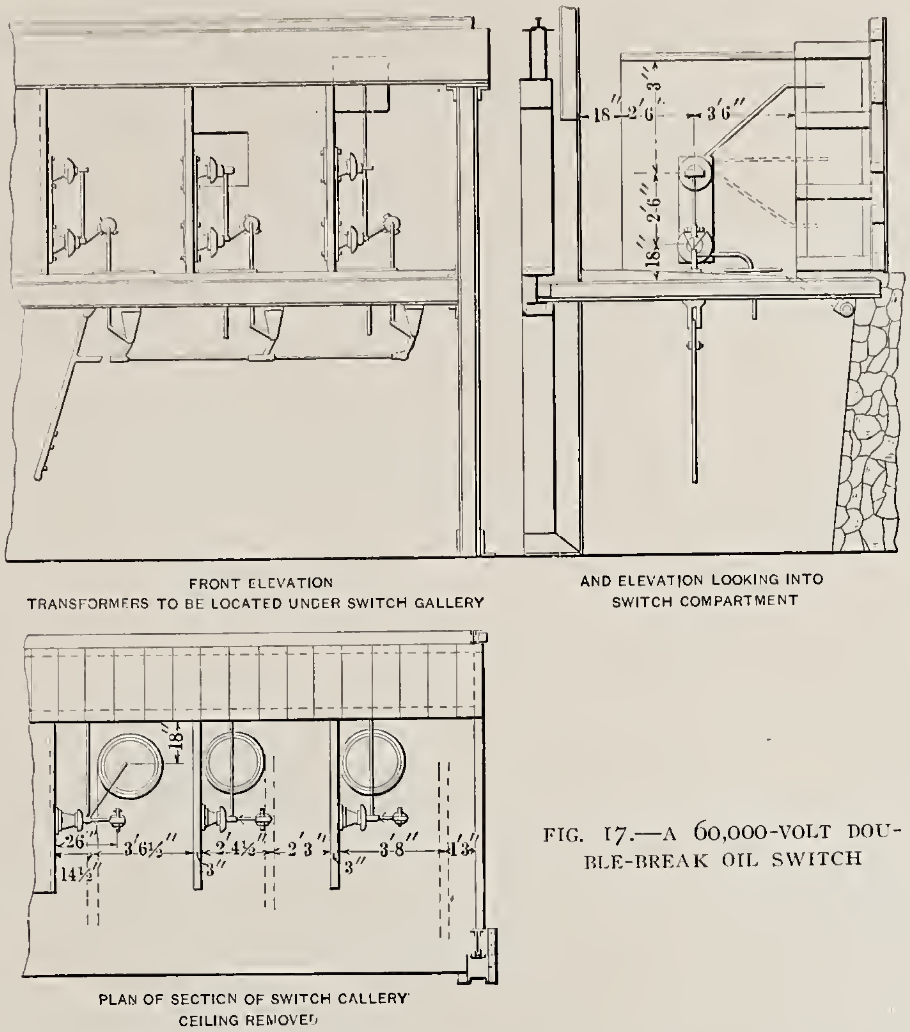


FIG. 17.—A 60,000-VOLT DOUBLE-BREAK OIL SWITCH

ments at sub-stations for connecting and disconnecting lines.

As evidencing the care exercised in protecting low-tension circuits from high-pressure wires where the low-tension parallels the high-tension, in the event that there should be any fall to the ground of the insulation of the high tension, Fig. 13 is fully illustrative.

Referring to the chart, Fig. 15, this station is midway between the Colgate plant, heretofore referred to, and the City of Oakland, on the bay shore. Each line shown represents a three-phase circuit, the large circles representing oil switches. Disconnecting switches are shown on each side of the oil switches. At the station represented in Fig. 12 there is no regular operator, and therefore in regular operation switches Nos. 1 and 3 are closed, and when necessary to open the line, switches Nos. 2, 4 and 5 are closed; then No. 3 or No. 1 opened, and then the oil switch No. 6, which opens the line.

In addition to the illustrations heretofore referred to, the difficulties attendant upon conveying material to the power houses will be noted in Fig. 1, which is an illustration of hauling the upper part of an armature of a 5000-K. W. generator to one of the mountain power houses. Thirty-six horses were required to pull this machine over six miles of mountain road, from railroad to head of pipe line, and the descent from the penstock down the mountain side to the power house, over four miles of the roadway, having a grade of approximately 10 per cent., was attended with more or less dangers.

Other than the line heretofore mentioned, conveying power from Colgate to the Bay of San Francisco, the line of the Standard Electric Company to the power plant at Electra on the Mokelumne River, a distance of 142 miles from San Francisco, is an illustration of the possibilities of the increase of the efficiency of a line by high insulation. When first constructed, this line was operated at 33,000 volts, which potential was maintained until March, 1904, when steps were taken to operate it in parallel with the other lines controlled by the California Gas and Electric Corporation, the Bay Counties and the Valley Counties companies, and it was at that time increased to 55,000 volts, and has been so operated ever since. The type of insulators in use in March, 1904, has been substituted for the four-part type illustrated, in such sections of the territory of the Standard as by reason of climatic conditions called for a higher insulation.

Outside of the immediate fog belt mentioned, the two and three-part types of insulators have been found extremely efficient for voltages up to 60,000, and experiments have been made to demonstrate that they will safely carry 80,000 volts without breaking down.

The progress made in the engineering and construction work of power houses has kept pace with the progress in pole-line work, and insulating and switching devices. The chart in Fig. 3 giving the areas of power houses, graphically shows the contraction of areas in the installa-

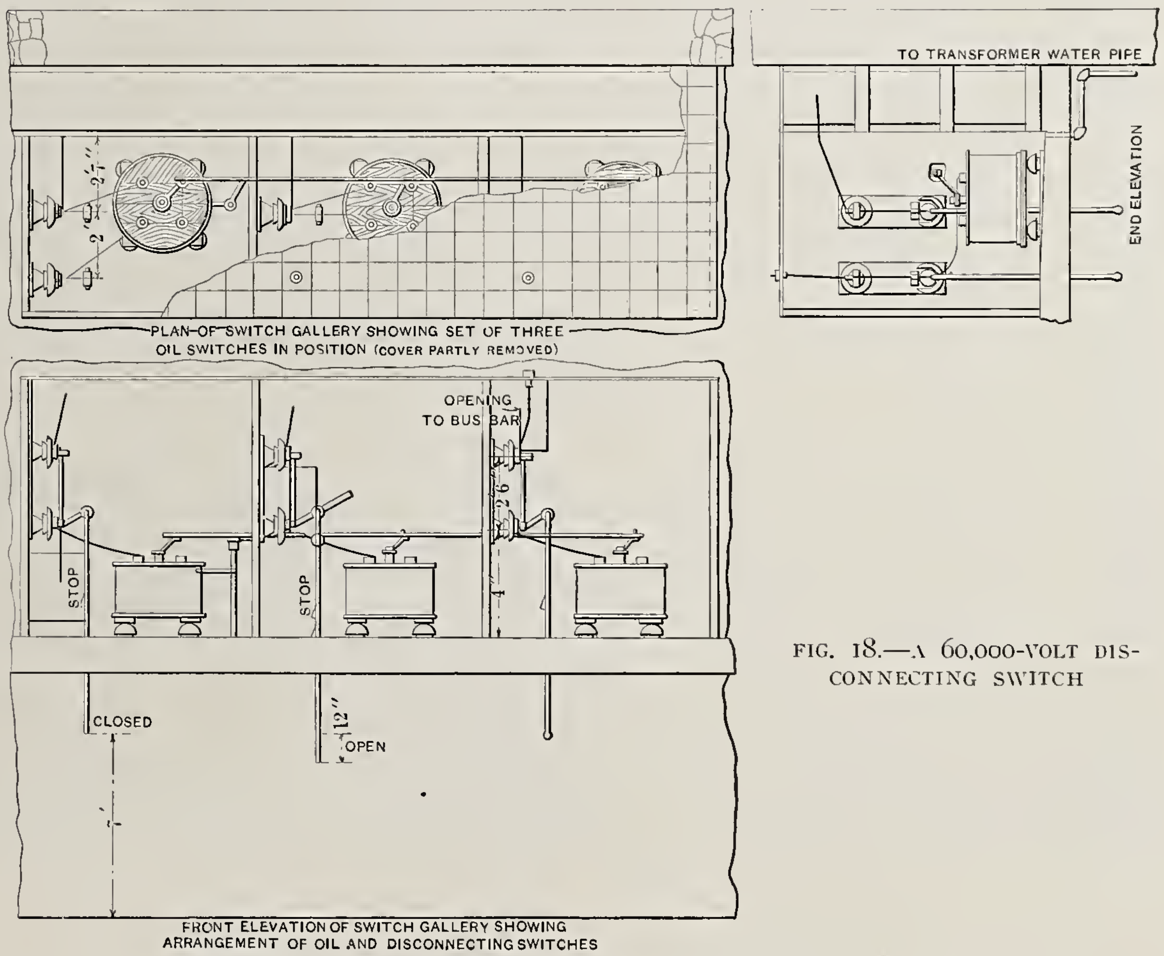


FIG. 18.—A 60,000-VOLT DISCONNECTING SWITCH

tion of large units, as it follows closely in the line of distributing stations, where, as can be remembered, the belted units for alternating-current work have increased from 35 K. W. to the large direct-connected units now in vogue, in some cases as high as 12,000 K. W. The first installation made at Electra, in 1899, of five 2000-K. W. units, called for a floor space equal to 1.16 square foot per kilowatt; the Colgate installation made in 1897, of 9400 K. W., called for 0.98 square foot per kilowatt; the recent installation at the de Sabla power house of the Valley Counties Power Company, of 9000 K. W., called for but 0.4 square foot per kilowatt. The installation now being made at Electra of two 5000-K. W. units, calls for but 0.288 square foot per kilowatt. The areas given include room for transformers, switches, etc.

It will be noted that the first installation at Electra required four times the floor space per kilowatt as compared with the work at present being done, and illustrates more clearly than words can convey the advancement in the past six years. It is believed that the floor area in the new Electra installation is less than that of any other power plant in existence to-day. In these plants there is no crowding of apparatus, and there is ample room for all operation or repairs, and in future work it will be safe to assume that this minimum of floor space can be still further reduced. Reduced floor area means, of course, reduced operating expenses, as well as reduced cost of construction.

When it is considered that the operation of these power plants extends to an infinity of uses, from the moving of street cars to the operation of sewing machines, from factories using ponderous machinery and exacting conditions of demand to the most minute uses to which electricity can be applied, and that during the four years of active operation on this coast new contracts are continually being made for the use of electricity against the installation of steam plants that might be operated with the cheapest fuel known (which is California oil at between 55 and 60 cents per barrel of 42 gallons), it is a tribute to the knowledge, perseverance and energy of the engineers that such work has been accomplished and so perfectly done in so short a space of time. Motors as large as 800 H. P. come on and off the line unnoticed.

From the point in the mountain stream where the diverting dam arrests the onward flow of the water, through the ditches constructed upon the sides of the chasms, and the flumes across deep canyons, to the utilization of such water at the water-wheel, and then along the lines by which the invisible current is conveyed over the many miles of copper and aluminum wires to points of distribution, there is exercised a watchfulness and care that is unceasing. Constant lines of patrol are maintained at the reservoirs, on the flumes and ditches, and along the pole lines, and direct telephone connection is made by the patrolmen, over private telephone lines, to the central power houses. By the construction of the double-pole line from the main power houses to the bay, constant service is insured, because it is but the work of a moment to switch the high potentials, by means of the switches illustrated, from one line to the other.

Experience with aluminum wire along the bay shores has demonstrated that it is impervious to the action of the atmosphere heavily laden with salt, and quite as effective in that regard as the copper.

A Telephone Museum at Purdue University

PURDUE UNIVERSITY, at Lafayette, Ind., has a telephone museum, according to E. C. Long in "The Telephone Magazine," the development from 1876 to 1905 being shown by various types of instruments and equipments.

The first accoustic telephone, made in 1835, consists of a tin cylinder, across one end of which sheepskin is stretched, a string, tightly drawn, connecting with a similar instrument from 300 to 500 feet distant.

Following the sheepskin and string apparatus, the tin diaphragm—a clumsy-looking affair in which string is still used instead of wire—came into existence. One had to rap on the diaphragm to call the party at the other end of the single line. About 1881, a Chicago company introduced a speaking tube to be used in connection with the telephone. The line had to be laid on a level and stretched tightly, the speaking tube covering the distance between the ear of the speaker and the mouth of the instrument, sometimes several feet above.

One of the exhibits is an accoustic switchboard, containing four transmitters and receivers. Connections were made from one to another by means of a hollow tube. A tight wire replaced the string which had hitherto been used. Another exhibit is the only transmitter of its kind in the world to-day, made by Dr. A. R. Critchfield, of Lincoln, Ill. Five little balls, suspended to as many wires, vibrate against the diaphragm when anyone is talking into the receiver.

Shortcomings of the Telephone as a Fire Alarm

IN pointing out the shortcomings of the telephone as a fire alarm, in a paper before the International Association of Municipal Electricians, Adam Bosch recently said:—

"In the use of the telephone for fire alarm purposes the personal equation enters very largely. Giving a notice of fire by telephone is a matter between the discoverer of a fire, the operator at the telephone central and the operator at fire alarm headquarters, with no record for verification. That misunderstandings and mistakes are more liable to occur under such conditions than when the alarm comes from a fire alarm box will be readily granted.

"Some persons' voices are not well adapted for telephone conversation, others have defects of speech; add to this the excitement incident to the discovery of a fire and we can easily understand why an operator is not in a very happy state of mind when receiving a telephone alarm. To fully realize this one must have encountered an excited Italian on the other end of the telephone trying to call the fire department.

"In the transmission of an alarm from a signal box, on the other hand, there is no unknown quantity of time; its action is instantaneous. In the problem of the transmission of an alarm of fire by telephone a number of unknown quantities of time exist,—the time consumed by the sender to obtain the attention of the central, the time required by central in making connection with fire alarm headquarters and obtaining the attention of the operator, the time consumed by the operator to obtain particulars about location of fire, and finally the time required by the operator to determine by reference to his map or telephone list the number of the nearest signal station to the locality. Theoretically some of these unknown quantities may be very small, but practically we know that their sum total of time is often very large, and it may easily be demonstrated that if an alarm from a fire alarm box and one from a telephone were started precisely at the same moment under conditions most favorable to the telephone the alarm from the box would be transmitted and the fire apparatus well on their way to the fire before the telephone alarm would be ready for transmission. There are other and weighty reasons which absolutely limit the use of the telephone for fire alarm purposes."

THE ELECTRICAL AGE

Established 1883

Volume XXXV Number 2
$2.50 a year; 25 cents a copy

New York, August, 1905

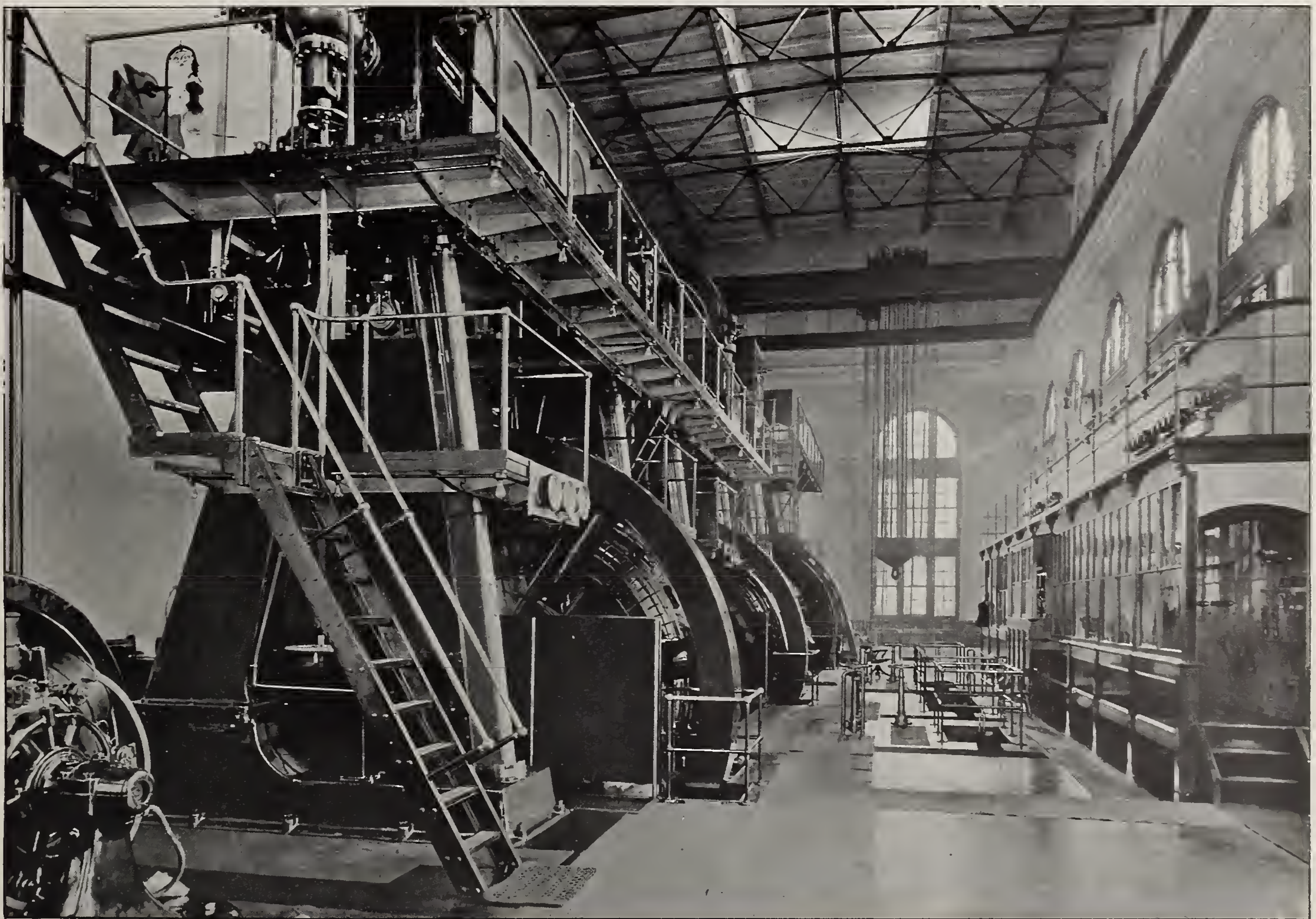
The Electrical Age Co.
New York and London

Some Noteworthy Features in a Central Station Design

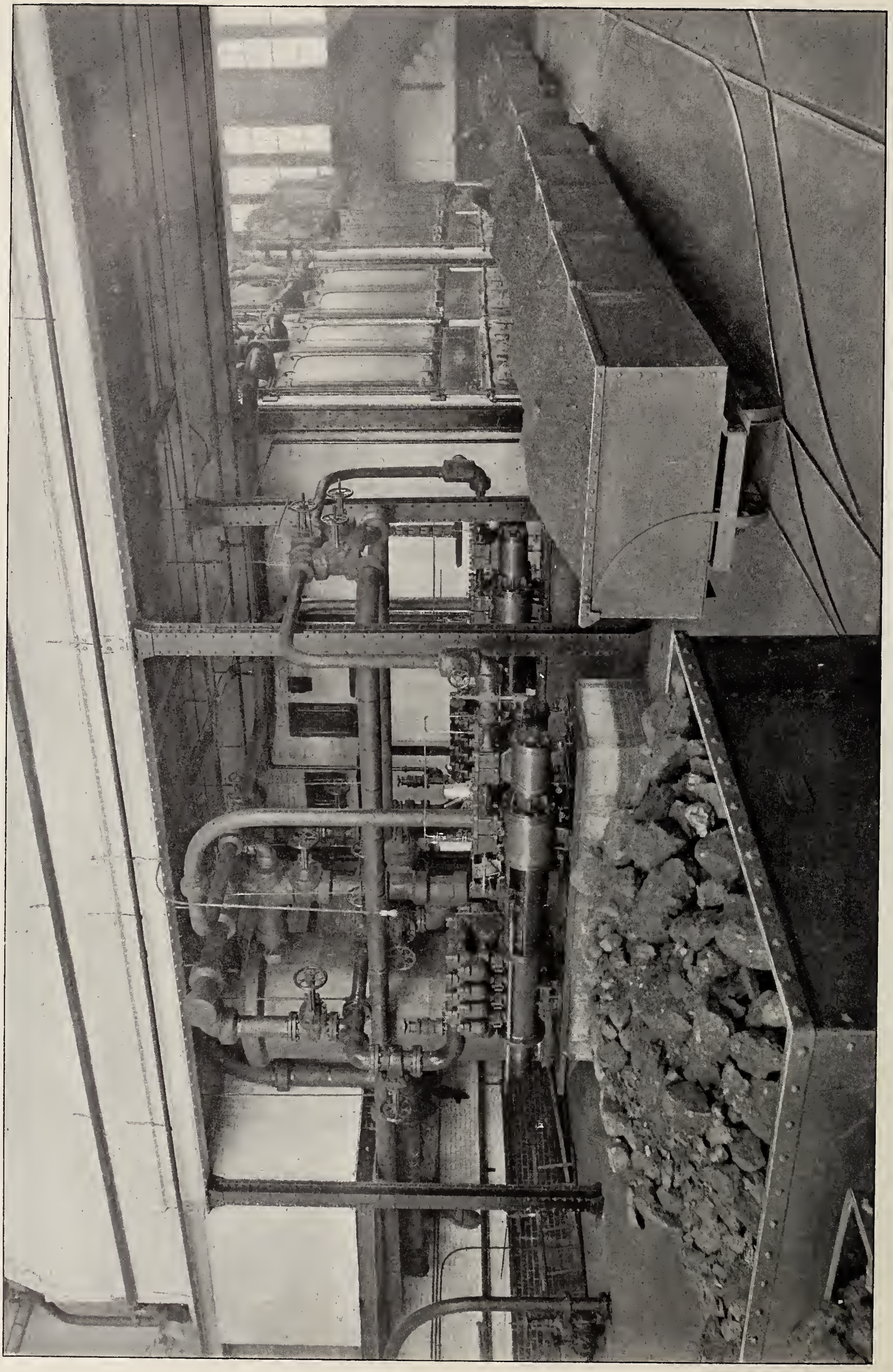
By H. S. KNOWLTON

THE design of a central station is always a matter of interest from the critical standpoint. Whether a plant is old or new, it is seldom impossible to pick out special features which are worthy of avoidance or imitation in subsequent work. The variation of conditions in different cities justifies radical departures in design, but there are always two fundamental points to be borne in mind,—reasonable first cost and operating economy.

A modern central station in which broad conceptions of design requirements prevail is that of the Cambridge (Mass.) Electric Light Company. The plant is located on the banks of the Charles River, and in its architectural appearance satifies unusually severe requirements. The route of the proposed Charles River Parkway—a piece of work which is commanding the best thought of the landscape gardener—lies along the river bank between the station and the water. Every effort was conse-



THE GENERATING PLANT OF THE CAMBRIDGE ELECTRIC LIGHT COMPANY AT CAMBRIDGE, MASS., CONSISTS OF TWO 600-KW. GENERAL ELECTRIC COMPANY ALTERNATORS AND ONE 1500-KW. ALTERNATOR, DIRECT CONNECTED TO VERTICAL, MARINE TYPE, CROSS-COMPOUND ENGINES BUILT BY MESSRS. McINTOSH, SEYMOUR & COMPANY, OF AUBURN, N. Y.



THE BOILER ROOM. TWO PARALLEL TRACKS, SET INTO THE CONCRETE FLOOR, RUN THE ENTIRE LENGTH OF THE ROOM. EACH CAR HOLDS ABOUT 2300 POUNDS OF COAL

quently made to erect a building which, as far as its nature permitted, would be an ornament to the locality.

The building was constructed of steel and brick, with pink granite foundations; the workmanship throughout is notably excellent, and the proportions are pleasing to the eye. It is 165 feet long, 100 feet wide and 85 feet high, with a copper cornice, surmounted by an iron grille. Between the building and the Parkway will be a lawn and shrubbery. As the plant stands to-day, it compares favourably in appearance with the pumping stations at Chestnut Hill, Mass., and other utilitarian structures of the Commonwealth's water supply. The window arches are graceful, and the remainder of the facade between the windows and the cornice is simply, but effectively, treated with a panel design. The stack is well proportioned, being of hard-burned, water-struck brick, 25 feet in diameter at the base and 255.5 feet high. When the overhead circuits leading into the station are placed under ground and the present temporary coal tower and sheds in front of the plant are torn down, there should be no lack of harmony between the completed Parkway's appearance and that of the power plant.

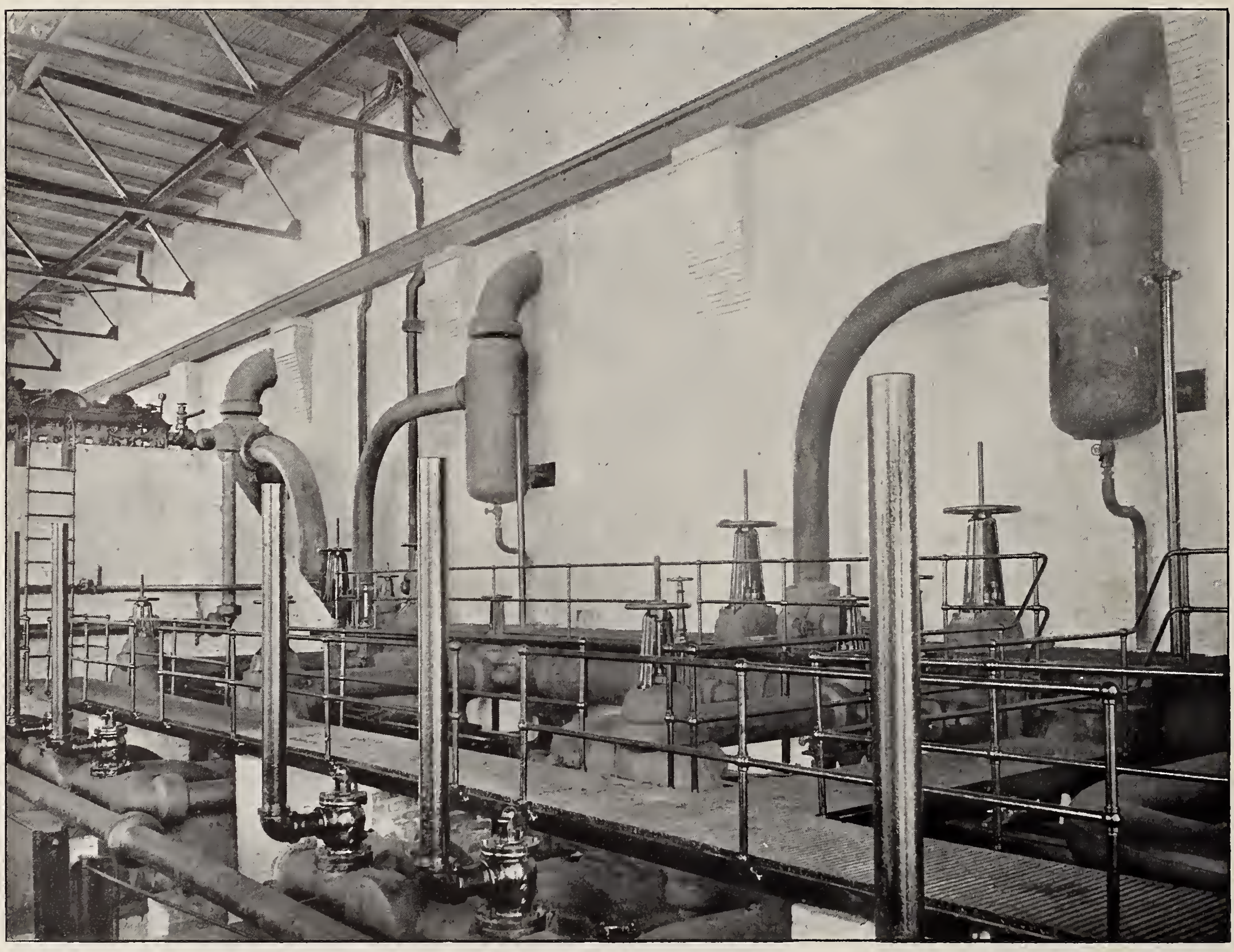
The handling of coal is an important question in all sizes of power stations, and in this case the problem was solved by a system of 20-inch gauge tracks and cars, the latter being sufficiently light to be readily pushed about by hand. As the rated generating capacity of the Cambridge plant is but 2700 KW., and the daily coal consumption is seldom in excess of 24 tons, the economy of mechanical conveying and stoking systems was open to considerable doubt. It was vitally important, however, that hand labour in the coal supply should be made as easy as possible, and the usefulness of the narrow-gauge trackage is unquestionable in bringing this about. The coal cars weigh about 975 pounds each, and are 5 feet long, 4 feet wide and 23 inches deep, mounted on a four-wheeled truck. Each car holds about 2300 pounds of coal. Two parallel tracks, set into the concrete floor, run the entire length of the boiler-room in front of the boilers, four cross-overs being provided for convenient transferring of the cars.

Each morning the empty cars are pushed out to the coal sheds, loaded and pushed back on the track farthest from the boilers. Scales are set in this track so that each car of coal may be weighed accurately, after which the loaded car is pushed over to the track nearer the boilers. The cars stand here ready for use, and are moved up or down in front of the two batteries as conditions require. They are equipped with drop sides, and the coal is shovelled directly from them into the furnaces, the distance being about 5 feet. The next morning all the cars on the track nearer the boilers are run back with any coal that is left, and weighed on the scales. In this way the daily consumption is readily determined.

Beneath the floor of the boiler-room, under the grates, a tunnel 8 feet wide runs the full length of the building. In the concrete floor of this tunnel is a track, and upon it runs a car which receives the discharge of ashes when it is placed beneath any of the hoppers leading from the grates. The car is pushed to the end of the tunnel, and thence upon a hydraulic elevator which raises it to the ground level, whence it is pushed to the dump.

The interesting feature of the feed-pump equipment consists in the use of two duplex, outside-packed, plunger pumps driven by tandem compound steam cylinders $6\frac{1}{2}$ by 8 by 12 inches. Each pump is capable of providing the water for 8000 H. P. of boilers. The speed control covers a range of from about 6 to 60 strokes per minute on each half of the pump. A commendable practice is the use of a dial thermometer in each cold-water supply pipe, the latter being connected with the city

THE POWER STATION OF THE CAMBRIDGE ELECTRIC LIGHT COMPANY, ON THE BANKS OF THE CHARLES RIVER



THE UPPER PART OF THE REAR OF THE BOILER ROOM. PLATFORMS AFFORD READY ACCESS TO ALL THE VALVES

mains. The pumps are set up in the boiler-room upon neat foundations of brick, and are easily inspected, adjusted or repaired. The entire boiler-room is walled with white or enamelled brick, and the large number of windows and doors affords a daylight illumination unusual in central stations. The ventilation is also noteworthy, the height of the boiler-room (60 feet) and the large doorways at the side and end conducing to comfort.

The feed-water heating plant appears to possess no unusual features. The feed-water temperature is raised to 212 degrees F. in the primary and secondary heaters, and from this point to 240 degrees in an economizer. The economizer tube scrapers are motor-driven, and there is the usual by-pass for the flue gases. The boiler plant at present consists of four 440-H. P. Babcock & Wilcox water-tube boilers, built to carry 200 pounds steam pressure if desired, the usual pressure being 150 pounds. The damper regulator regulates within 2 pounds above or below normal steam pressure.

Accessibility and simplicity characterize the high-pressure piping. From each boiler an 8-inch pipe carries the steam to a 16-inch main 42 feet in length, extending along the wall behind the boilers. Any 10 feet of pipe desired may be cut out by valves. The engine separators and receivers are located on the boiler-room side of the dividing wall between the engine and boiler rooms. This enables the steam to be carried directly into the high-pressure cylinders of the engines and obviates the necessity of introducing the rather cumbersome separator into the engine-room.

A conspicuous and most convenient feature of the boiler-room is the construction of an iron platform with railings and stairs above the boilers and piping, so that all the valves are easily and quickly reached. Unusual care has been taken to enable the operating force to cover all important points rapidly and comfortably. This is a point often neglected in power-plant design, and one which has a close relation to the character of maintenance enjoyed. Behind the boilers is a passageway 10 feet wide to facilitate repairs, and the room is equipped with a 5-ton hand-operated travelling crane.

A high percentage of the station output is alternating current, as all the residence and street lighting, arc and incandescent, is carried out in this manner. Practically the only direct current supplied by the plant is that sold to users of small motors in the Haward square district. Hence the main generating units consist of two 600-KW. and one 1500-KW. alternators, supplying current at 2300 volts, 60 cycles, each being direct driven by a vertical, marine type, cross-compound engine. Direct current for commercial use is supplied from two motor-generator sets, each consisting of a 100-KW., 550-volt generator, direct coupled to a 150-H. P., 2300-volt induction motor. In harmony with the best practice of

to-day, the exciters for the alternators are motor driven. Each supplies direct current at 110 volts, one being rated at 35 KW. and the other at 50 KW. The motors for these sets take current at 2300 volts.

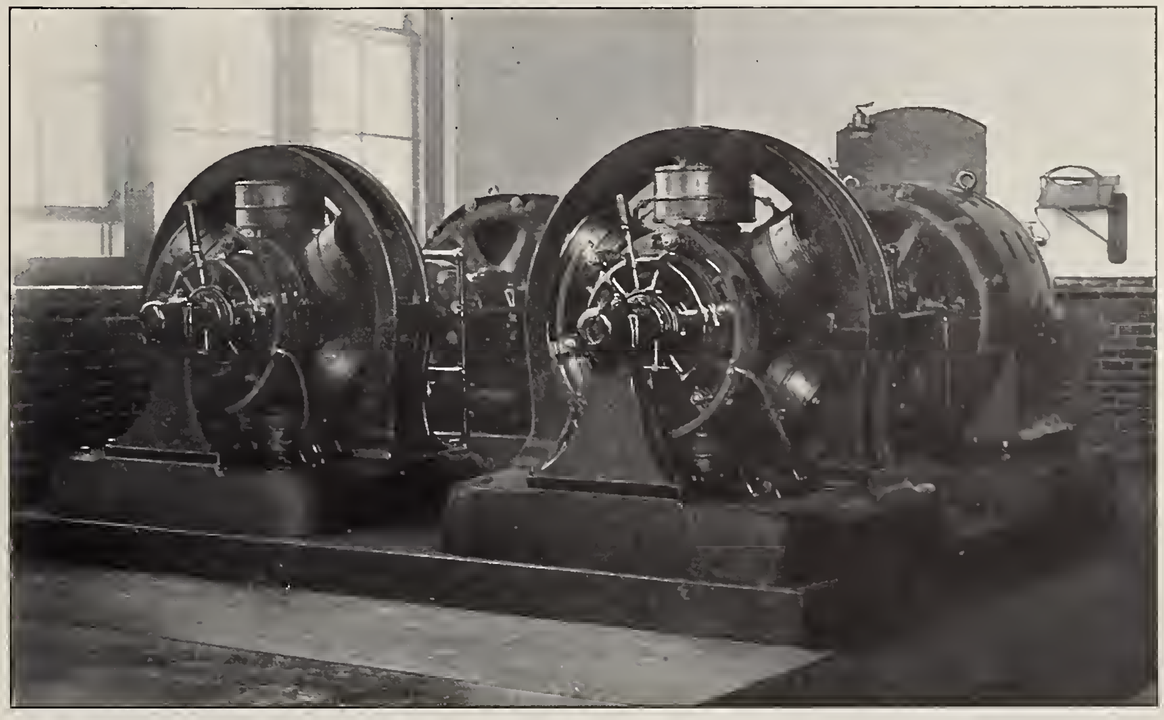
The convenience of so large an alternating-current output is noteworthy, and the simplicity of the electrical design in the plant largely depends upon it. The use of alternating, enclosed-arc lamps in the Cambridge streets is an important factor in this unifying of the system. In this case it certainly has worked out as a great gain to generate all the current of the plant at one voltage,—2300,—and to carry the 2300-volt bus-bars along 75 per cent. of the switchboard's length. The board is 60 feet long, and is made up of fine Vermont marble panels. Two duplicate sets of three-phase busses are provided, each bar being of copper, 5 inches wide and ¼ inch thick.

One needs only to contrast the frequently-met central station with its possible stationary transformer, rotary converters, batteries, boosters, both direct and alternating generators, synchronous, motor-driven, direct-current arc machines and what not, to realize the significance of the Cambridge installation as an example of how the electrical needs of a present-day urban community may be met by a simple design; with the exception of the 550-volt, direct-current lines mentioned, the 2300-volt, alternating-current circuits take care of all the power and lighting supply drawn from the plant. The only transformers used in the plant, aside from the switchboard instrument equipment, are the constant-current "tubs" in the basement, which supply the arc circuits with 6.8 amperes at from 2000 to 4000 volts. About 600 arc lamps are in use, with about 470 40-candle-power incandescents on the same circuits in series with the arcs.

An unusual departure is found in the use of compressed cork tiling for the engine-room floor. This material presents a good appearance, is easily cleaned, comfortable to walk on, and a good insulator. The switchboard is protected on the engine side by glass panels, and the engine-room is served by a hand-operated crane of 30 tons capacity. The basement contains the condensing equipment, in addition to the constant-current transformers. This is of standard design, but the same platform and stairway arrangements employed in boiler-room are found. Accessibility is as prominent a feature of the basement and of the wiring design as it is of the piping

THE ASH PIT UNDERNEATH THE BOILER ROOM

layout. In the basement is also installed a small, steam-driven exciter set used in case the plant is entirely shut down and started again. There is also a 5-H. P., 550-volt motor, geared to an air compressor, which is used in connection with the oiling system and for cleaning purposes



DIRECT CURRENT FOR COMMERCIAL USE IS SUPPLIED FROM TWO MOTOR GENERATORS, EACH CONSISTING OF A 100-KW., 550-VOLT GENERATOR, COUPLED TO A 150-HORSE-POWER, 2300-VOLT INDUCTION MOTOR

around the generators and motors. A sound-proof telephone booth is installed in the engine room.

In the foregoing comments upon the design of what is certainly one of the most attractive of recent central stations in Massachusetts, there has been no intention to urge that the details should always be followed closely in other reconstruction work. It is important to remember that while Cambridge is the seat of considerable manufacturing, its main functions are residential and educational. Alternating-current motors are used in the manufacturing district, but there is little demand for the low-potential, direct-current distribution employed so extensively in the business centers of New York, Boston or Chicago. This fact tends to a simplicity of design not always attainable in larger cities.

The population of Cambridge at the last census was about 96,000. On this basis the gross earnings of the company per capita for the last reported year, 1903-4, were $2.35, and the operating ratio, 57 per cent. A study of the Western avenue plant and a survey of the field it serves lead one to the conclusion that it is destined to play an important part in the profitable development and maintenance of the company's business. When expansion of output demands new equipment it is not unlikely that the turbo-alternator will find a place in the plant. In any event, the station deserves a visit from engineers chancing to have a few spare hours in Boston, and in its design offers many suggestive hints worth thinking about in small or medium-sized urban plants.

Detecting the Presence of Fish by Telephone

ACCORDING to a recent consular report, a Norwegian has invented a telephone by which the noise made by fish can be heard. The instrument consists of a microphone in a hermetically-sealed steel box, connected with a telephone on shipboard by wires, each sound in the water being intensified by the microphone.

The inventor asserts that with its aid the presence of fish, and approximately their number and kind, can be recognized. When herrings or smaller fish are encountered in large numbers they make a whistling noise, and the sound made by codfish is more like howling. If they come near the submarine telephone their motion can be distinguished. The flow of water through the gills produces a noise similar to the laboured breathing of a quadruped.

The Cape Cod Wireless Telegraph Station

AT HIGHLAND LIGHT, MASSACHUSETTS

AN interesting wireless telegraph station operated by the United States Navy Department is in service at Highland Light, North Truro, Mass. The plant is located on the bluffs, 140 feet above the sea, close by the marine signal station of the Boston Chamber of Commerce, and about 600 feet from the famous Highland Light which caps the summit of topographical elevation on the cape. The wireless equipment is installed in a small frame structure, the receiving and sending aerial circuit being supported by an Oregon pine mast extending 180 feet above the ground, set in 12 feet of concrete in front of the signal house. The wire cage which receives and transmits the electrical waves is thus located about 300 feet above sea level.

The mast is built in three overlapped sections, 100, 60 and 35 feet in length and 26 inches in diameter at the bottom, where the concrete begins. As the winter gales off the Highlands are extremely severe, often reaching velocities of 60 or 70 miles an hour, special care was needed to properly guy the mast. Each section is guyed with four cables at right angles, anchored 15 feet in the ground to "dead men." There are 12 stays all told, the upper 8 being made of hemp, to prevent the discharge of high-potential waves to the ground. The lower stays are of stranded steel wire 2 inches in diameter. The cage consists of a cylindrical framework of phosphor bronze wires 60 feet long, and spaced by 5 circular rings, the diameter of the cylinder being 24 inches. There are 8 parallel wires in the cage, each of No. 10 B. & S. gauge. All the wires are connected at the bottom of the cage to an antenna wire 186 feet long, which leads into the signal house below. The last 12 feet of this run are insulated to keep the high-potential sparks from the house wall, and the top of the cage is supported by a rope in which is fastened a hard rubber insulator 2 inches in diameter and 18 inches long, to prevent the discharge passing to the pole. The cage may be raised or lowered by a pulley system, and a ladder extends to the top of the second mast, for inspection and repair purposes. Where the antenna cable passes through the wall of the signal house another rubber bushing is inserted.

The Slaby-Arco Telefunken system is at present employed in the Highland wireless station. Power is obtained from a set of 40 cells of the chloride accumulator made by the Electric Storage Battery Company of Philadelphia, set up in an engine and battery house adjoining the station proper. The battery has a discharge capacity of 40 amperes at the 1-hour rate, and it is charged by a 3-KW., shunt-wound, 125-volt generator built by the Crocker-Wheeler Company, of Ampere, N. J., and belt driven at 1500 revolutions per minute by a 7-H. P. Hornsby-Akroyd kerosene oil engine built by the De La Vergne Machine Company, of New York. The generator is equipped with a small fly-wheel to enable it to tide over any missing explosions in the engine cylinder. A switchboard panel in the engine house enables the current for the signalling instruments to be drawn from the battery or generator, or both together.

The maximum potential used in the primary circuit of the induction coil is 80 volts, giving a secondary electromotive force of from 60,000 to 100,000 volts. The maximum current used in the induction coil primary circuit is 30 amperes; that is, 2.4 KW. is the maximum power employed in wireless transmission at this station. The interrupter for the primary circuit is of the mercury break type, driven by a 1-12-H. P., 80-volt motor. The range of breaks ordinarily used varies from 2400 to 3600 per minute. In sending messages, the length of spark gap in the Leyden jar case seldom exceeds 2 centimeters. In the bottom of the Leyden jar case is a 65-volt fan motor used to expel the ozone produced by the spark discharge, which would otherwise corrode the metallic connections inside the apparatus.

The receiving apparatus is concentrated in a coherer, an 80,000-ohm polarized relay containing about 6 miles of wire, dry batteries, a relay and sounder or automatic tape recorder. Special inductances of an adjustable type are employed for tuning the circuits when necessary. Ordinarily the United States naval wireless stations are tuned for a wave length of 320 meters, or about 5 waves per mile, so that other stations calling the Government, tune their equipment to this wave length before commencing to signal. The ground plate at Highland Light consists of 150 square feet of copper plate buried 12 feet deep in clay, which is occasionally dampened from above.

At present the range of the Highland Light station is about 200 miles. Communication has been had with Bar Harbor, Me., and regular service is maintained between Portland, Me.; Cape Elizabeth, Me.; Portsmouth Navy Yard; Thatcher's Island, off Cape Ann, Mass.; Boston, Cape Cod and the Nantucket Shoals lightship. In sending from Cape Cod to Portland, 92 miles, a ½-centimeter, or 0.19-inch, spark is used, requiring 10 amperes at 60 volts in the primary circuit. Between Cape Cod and Portsmouth, Thatcher's Island or Boston, 8 amperes at 60 volts are required in the primary. The large number of high buildings in Boston in the vicinity of the Navy Yard at Charlestown explains the necessity of using the same power employed in sending farther north. In transmitting to Bar Harbor 12 amperes at 80 volts were required in the primary.

It is probable that the range of the Cape Cod station will be increased in the not distant future by the addition of improved and higher-powered equipment. The station is connected with the Western Union Telegraph Company's land lines, and each day at 12 noon time signals are flashed seaward by the wireless plant at Highland Light for the use of vessels equipped with such apparatus. The line relay actuated from the Naval Observatory at Washington is arranged to close a solenoid circuit which depresses the wireless sending key of the Highland station in exact synchronism with the beats of the Washington signals. Vessels are given the time of day, weather reports, or any other reasonable information, from the naval stations, and commercial wireless messages are repeated to the Western Union Company without charge. In connection with the movements and manœuvers of battleships, cruisers and other Government vessels, the chain of wireless stations along the coast line is of great usefulness. The Highland Light station is in charge of Chief Electrician John Donnell, U. S. N.

Six electric omnibuses are to be used in Lima, Peru, to perform all the functions of the ordinary street railway. The cars are 28 feet long and will seat 32 passengers. The seats face forward and are separated into two rows by an aisle running the length of the car. Straps are also provided for standing passengers. Each car is equipped with 44 storage-battery cells.

The Future Supply of Crude Rubber

In a recent address before the New England Rubber Club, S. P. Colt said that the future prosperity of the rubber business, if not its very existence, hinges upon the satisfactory solution of the problem of obtaining in the future sufficient quantities of crude rubber for the world's requirements.

Statistics show that in the past twenty years the imports of crude rubber into the United States have increased from 24,000,000 pounds to 62,000,000 pounds per annum, and the annual value from $10,000,000 to $44,000,000. In 1904, 34,500,000 pounds came from Brazil, while Africa shipped most of the remainder. Comparatively small quantities were shipped from the Central American States and Mexico.

These rapidly increasing imports and the increase in price demonstrate that the present demand for crude rubber is greater than the supply, and there is reason to believe that the past ratio of increased demand will continue for the next twenty years.

If we husband the supply by reducing the quality of the product, the result would be most disastrous, and the range of substitutes is very narrow. In the few instances in which a substance resembling rubber has been discovered, the article has been inferior, the cost of production high, or the quantity produced small. The cultivation of the rubber tree, which has been undertaken in Mexico, Central America, Ceylon and other countries, although so far not a factor, may in time yield results.

It is evident that neither immediate or permanent relief lies in these directions. Such relief must be looked for in increased production of rubber in those vast regions which are watered by the Amazon and the Congo. The growth of rubber trees extending inland from the banks of these rivers and their tributaries is simply inexhaustible. The material is all there in sufficient quantities to supply our wants for a hundred years. It only awaits the hand of man to gather it. It does not lie hidden in the bowels of the earth. It is visible to the eye, and covers regions thousands of miles in extent.

It is to the Pará of the mighty Amazon Valley that we must look for the permanent solution of the crude rubber problem. That valley is capable of yielding quantities of the best gum in the world for the next fifty years, equal to two or three times the present demand, if the labor can be had and improved methods devised to obtain it. It is the only species of rubber that can be economically and successfully gathered by tapping the trees without injuring their vitality and productiveness. For the past fifty years this rubber has been taken by this process from the same trees on the banks and inlands of the Amazon.

This rubber tree always grows in groups, and the labor involved in tapping 150 to 200 trees a day is less than the work of cutting down and extracting the milk from a single tree. Again, these trees grow near the banks of navigable streams, thereby affording economical and convenient facilities for transportation. Further, they can be tapped almost daily and continuously from year to year, and will sustain almost any demand if the vast forests in which they abound are opened up, taken care of and properly worked.

By systematic development and effort the production of Pará rubber can be established upon a permanent basis, which will give it a position among raw materials practically as reliable as cotton or corn.

The International Association of Municipal Electricians

The tenth annual convention of the International Association of Municipal Electricians will be held at Erie, Pa., on August 23 to 25. The following papers will be presented and discussed:—

"The Effects of Electrostatic Influence in Telephone and Telegraph Circuits," H. R. Allensworth, Columbus, Ohio.

"The Advisability of Fusing Fire and Police Telegraph Boxes," C. E. Diehl, Harrisburg, Pa.

"Electric Light Engineering," A. S. Hatch, Detroit, Mich.

"Erection and Maintenance of Electric Lighting Plants," C. L. Williams, Meridian, Miss.

"Suggested Improvements in Fire Alarm Telegraph Systems," Capt. Wm. Brophy, Boston, Mass.

"The Necessity of a Rigid Inspection by the Municipality," T. C. O'Hearn, Cambridge, Mass.

"Underground Construction," Louis Gascoigne, Detroit, Mich.

Frank P. Foster, of Corning, N. Y., is secretary of the association.

It is reported that the largest searchlight in the world has been built by Siemens & Schuckert, of Berlin, for the Russian Government. It is of 316,000,000 candle-power, taking a current of 200 amperes. The reflector measures 6 feet in diameter and the lamp's carbons are 6 inches in circumference.

The Publication Bureau of a Large Industrial Company

By MARTIN P. RICE, M. E.

MARTIN P. RICE, M. E., CHIEF OF THE PUBLICATION BUREAU OF THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

IN the growth of the organization of any large industry, similar work is grouped together for economical reasons, and as development proceeds a process of arranging and rearranging goes on, thus building up certain recognized departments. Such a process has produced the modern publication bureau, and its scope legitimately includes the supervision of all printed information issued by an industrial corporation, whether in the form of catalogue, circular letter, magazine article, advertisement, photograph, blue print, or technical report. Without entering into a discussion of the importance of such a department—now generally recognized as indispensable—it may be interesting to consider its organization and operation.

A completely equipped bureau includes an executive department, a corps of technical writers, statisticians, and illustrators, and departments for photographing, photo-engraving and electrotyping, printing, and mailing. Whether some of these departments are omitted in the organization depends upon the amount of work handled and local conditions. An industrial enterprise located in a large city where competition among printers is severe might put out part or all of its printing and thus dispense with the printing department; but, in general, a large plant manufacturing a varied product will find the photographic department a necessity and the photo-engraving and printing departments economical and extremely convenient if properly managed.

A bureau provided with such departments naturally takes charge of all printed matter required within the

FIG. I.—THE REFERENCE LIBRARY AT THE WORKS OF THE GENERAL ELECTRIC COMPANY—AN IMPORTANT ADJUNCT TO THE PUBLICATION BUREAU

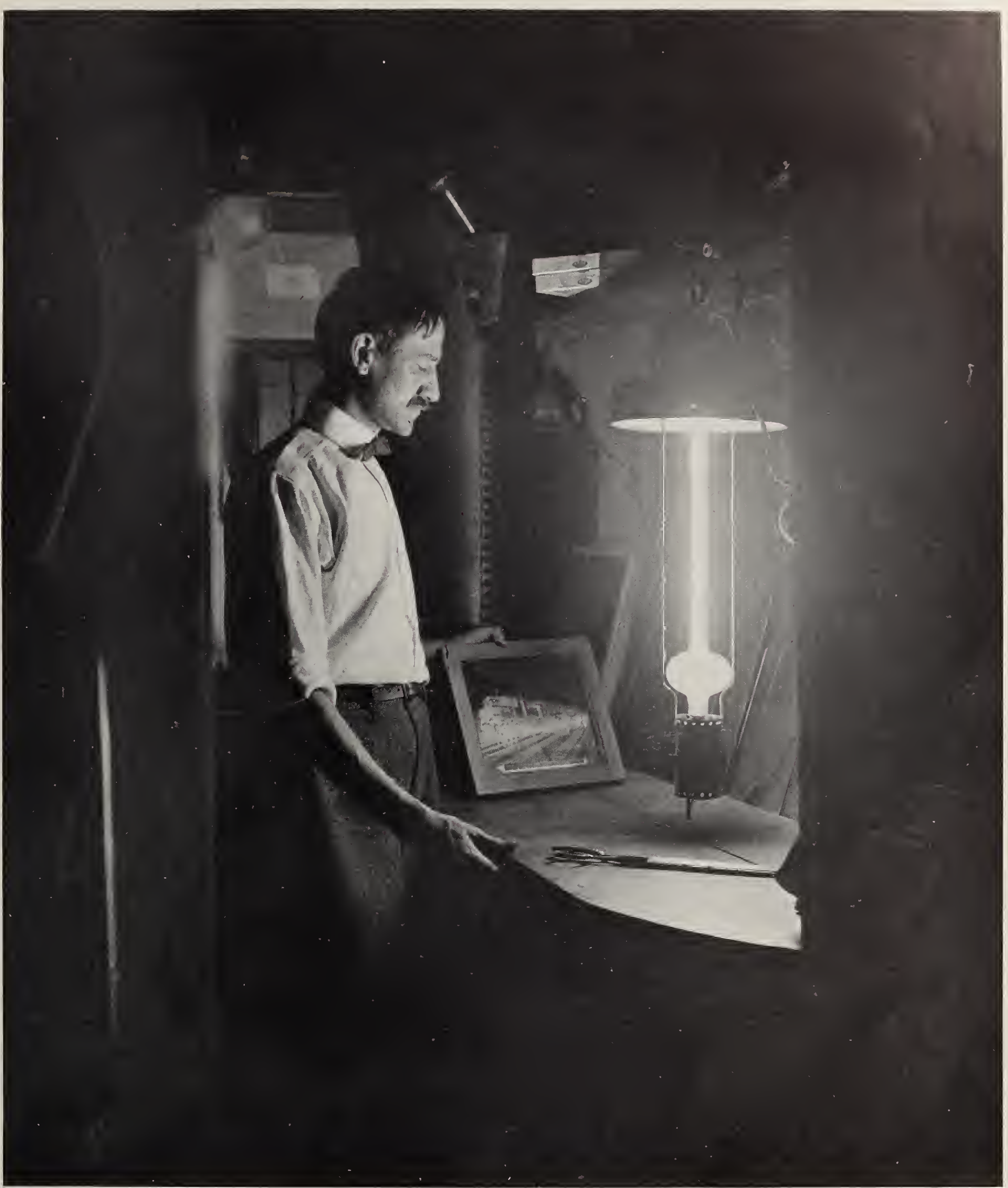


FIG. 2.—A MERCURY VAPOUR LAMP FOR PHOTOGRAPHIC PRINTING. MORE THAN 30,000 PRINTS HAVE BEEN MADE WITH THIS LAMP

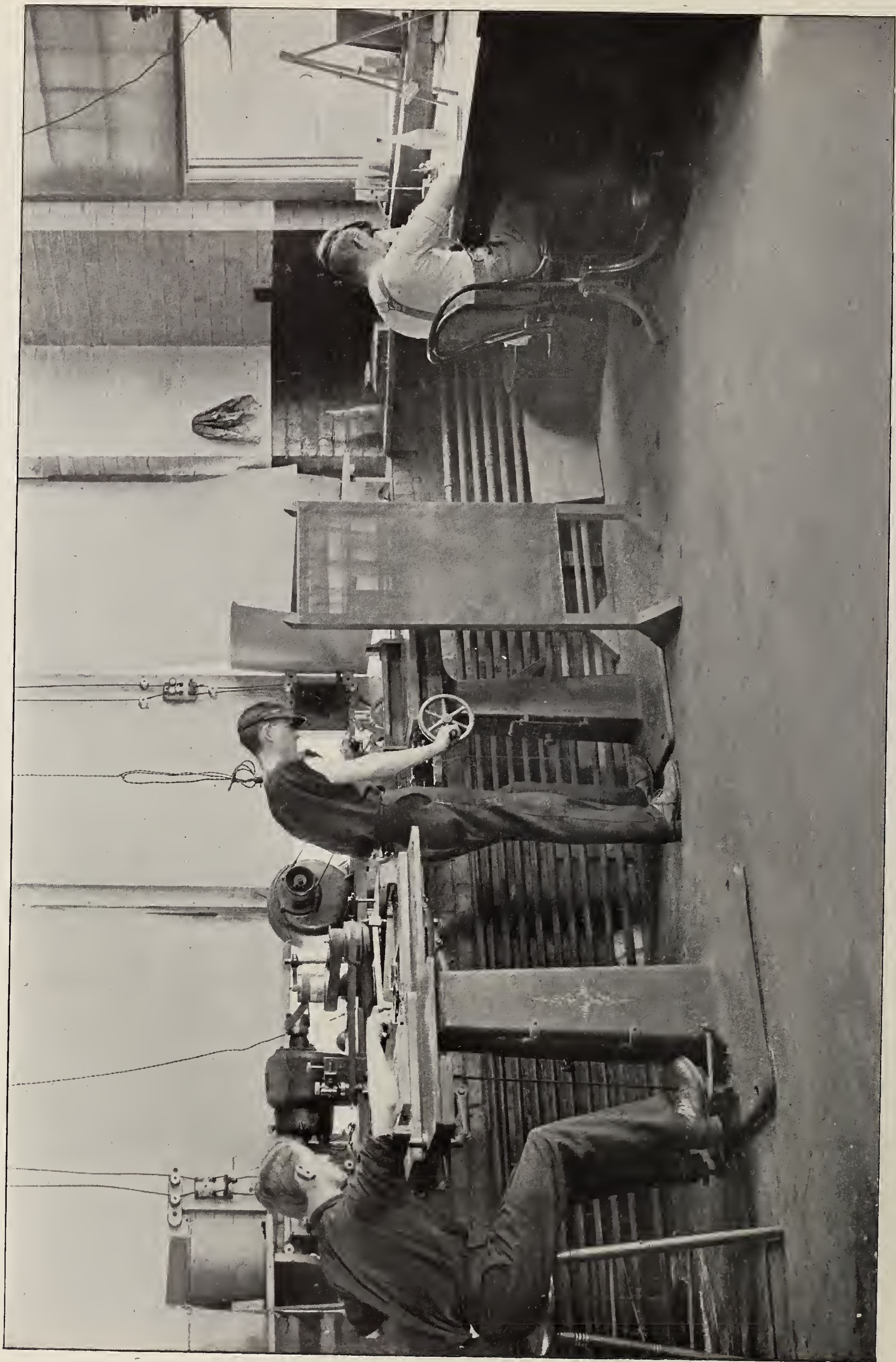


FIG. 3.—THE PHOTO-ENGRAVING DEPARTMENT. THE ROUTER AND BEVELER SHOWN ARE ELECTRIC-MOTOR DRIVEN

organization, as well as that published outside, and it has at its disposal various duplicating machines and processes in addition to the usual printing presses. The executive head of the bureau, in addition to possessing a thorough literary and engineering education, must be somewhat of a specialist in photography, engraving and printing; although his real value, as in other executive positions, will depend largely upon his ability to choose efficient assistants for the various lines of work.

A brief sketch of the organization and operation of the publication bureau of the General Electric Company, one of the most complete in its line, may be of interest. The officers of the bureau include the executive, technical writers, statisticians, illustrators, draftsmen and distribution clerk with assistants. One writer makes a specialty of catalogues and descriptions of railway apparatus; another prepares catalogues of supplies; a third edits a magazine issued to the employees of the company—and thus the work is divided according to its character among the various men.

In these offices all construction specifications, the original records of every test and technical reports on every series of tests made in the company's testing department are filed for reference in case of inquiry by customers or the company's engineers. These records, extending over a long period of years and including definite results of tests in almost every department of electrical investigation, constitute one of the company's most valuable assets in the design of new machines. Armature, field winding and general specifications, and all formal instructions from the engineering department to the factory are issued by the publication bureau. The draftsmen of this department prepare diagrams of connections and name-plate designs for all apparatus manufactured by the company. The work of the department also includes the preparation of catalogues of parts, in which, according to modern practice, is provided a separate designating number for every replaceable part of every machine or piece of apparatus.

The photograph house is a one-story building about 50 by 40 feet, provided with a skylight, a narrow-gauge car track with a turn-table, and fitted with three dark room,—one for making enlargements, one for dry plate development, and one for contact prints. All portable apparatus is carried to the photograph house on the narrow-gauge track and photographed under the skylight without moving from the car. Large turbine-generators and similar machinery must of course be photographed in the erecting shop, or during the test.

The problems presented to the photographer sometimes require special skill and the improvising of new methods. In this class may be mentioned photographs of lightning-arrester and circuit-breaker tests and high-speed electric locomotives in action. Moving-picture machines have been employed to obtain photographs to illustrate the various operations of a new device, or the various steps in a process. In general, when any

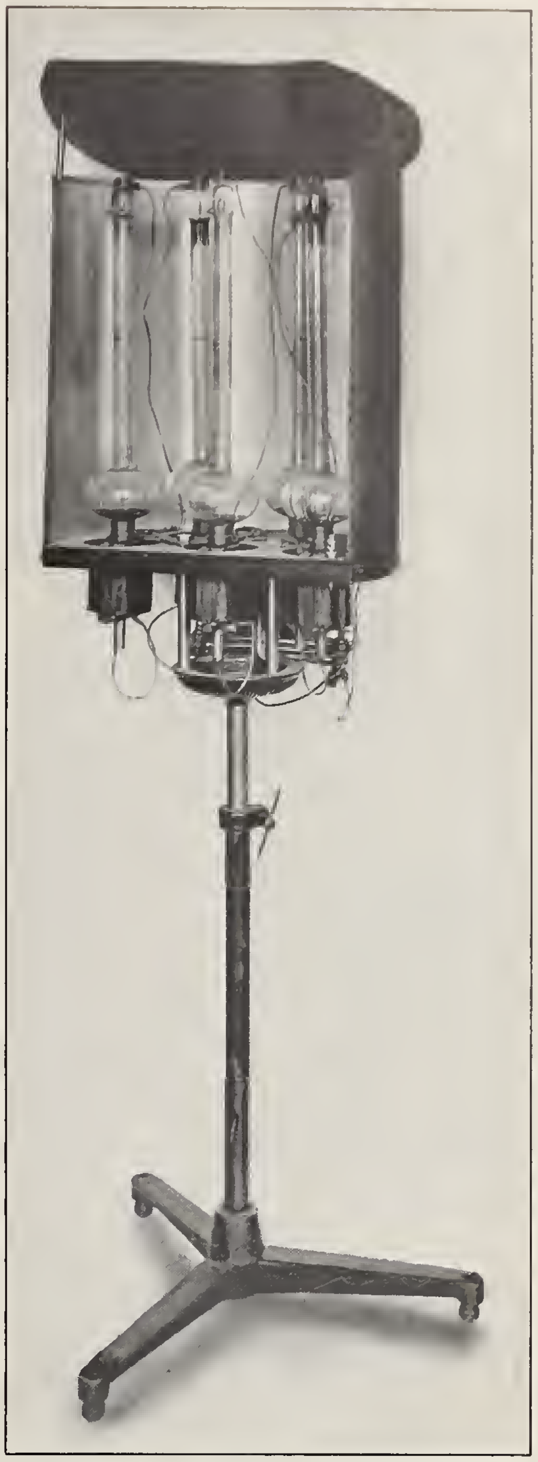


FIG. 5.—ONE OF THE MERCURY VAPOUR LAMPS FOR PHOTO-ENGRAVING

FIG. 4.—ARC LAMPS USED IN THE PHOTO-ENGRAVING DEPARTMENT FOR PRINTING ON METAL

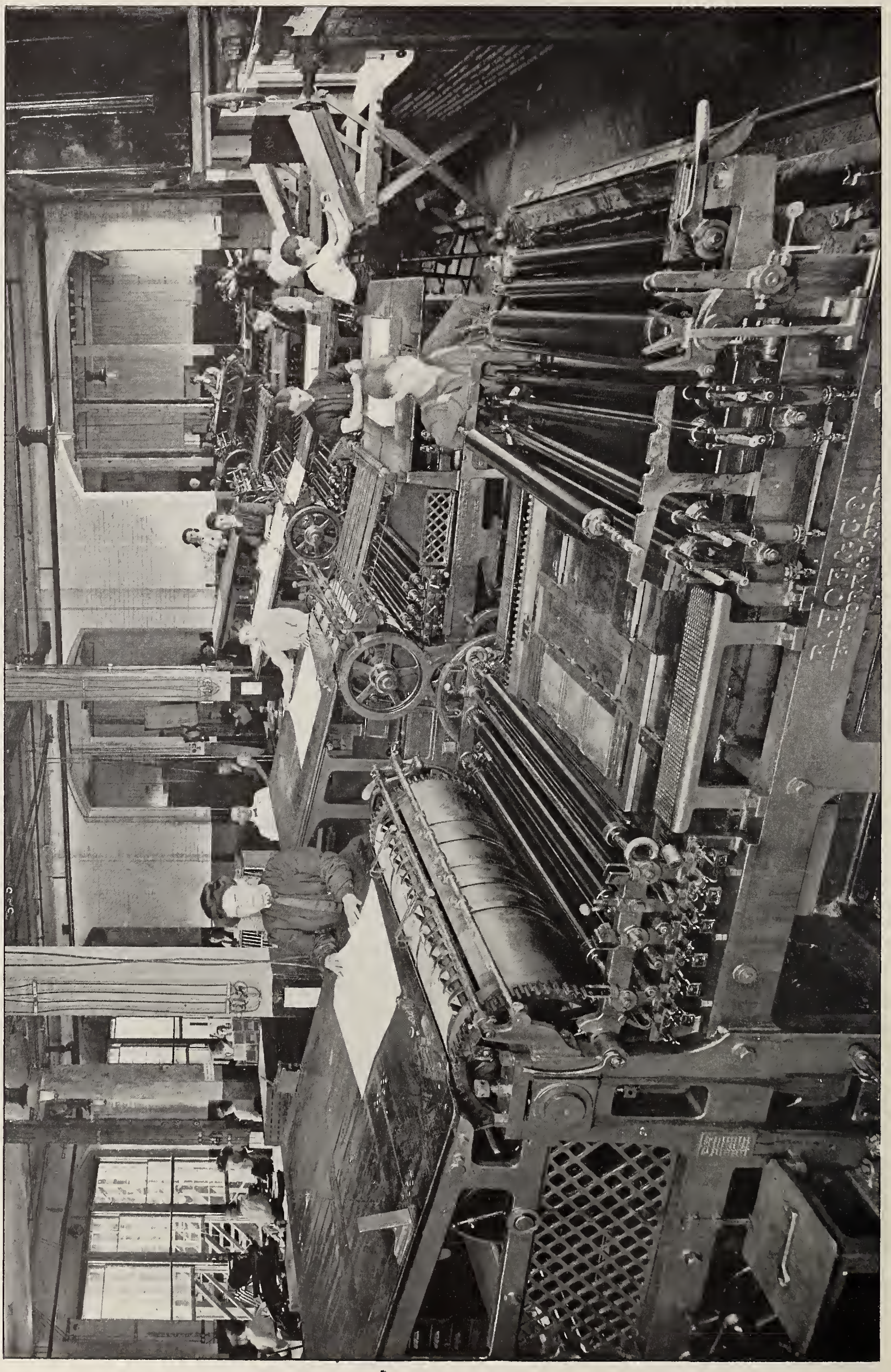


FIG. 6.—A PART OF THE PRINTING DEPARTMENT, SHOWING THE ELECTRICALLY DRIVEN CYLINDER PRESSES

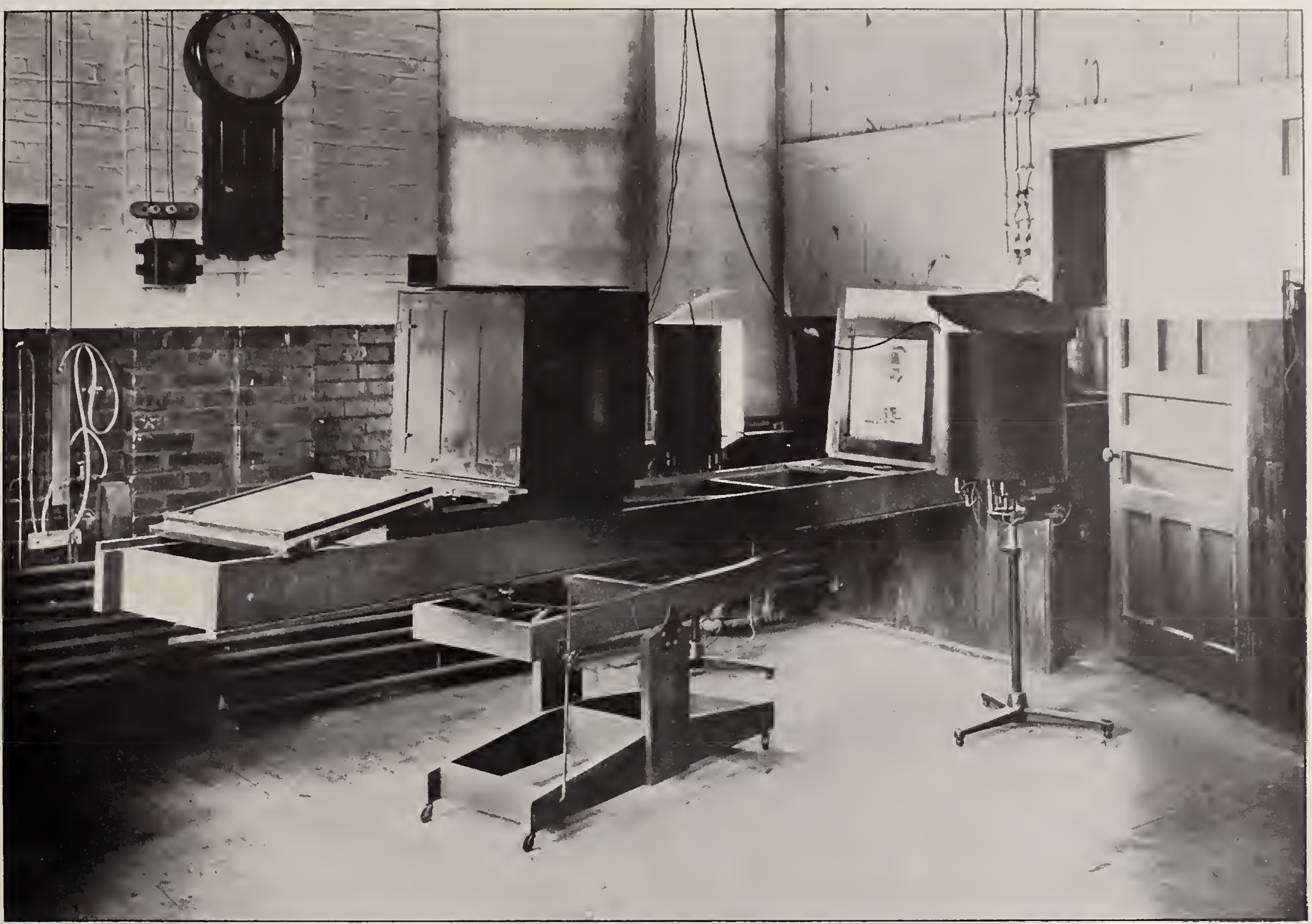


FIG. 7.—MERCURY VAPOUR LAMPS OF THE KIND SHOWN IN FIG. 5 ARE HERE USED IN MAKING NEGATIVES

problem is presented, the photographer takes it up with untiring energy until it is solved.

Photographs now have an important place in every formal proposal, and the capacity of the plant is sometimes taxed to the utmost to provide the required number of prints in the short time allowed. No allowance can be made for cloudy days, and a printing process with artificial light must therefore be employed. The simple frame shown in Fig. 10 is constructed of angle iron and provided with five direct-current enclosed arc lamps. It accommodates about thirty 8 by 10-inch printing frames, and, when working with glass negatives and blue-print paper, will produce prints of good density in five or six minutes. More than 5000 prints per week can be made on this frame if necessary.

For commercial work, "developing out" papers have practically superseded "printing out" papers on account of the great saving in time. The dark room for contact prints is equipped with a single mercury vapour lamp of General Electric design which has been in service for more than a year. It is shown in Fig. 2. It is installed on a 110-volt, direct-current circuit, and will make a satisfactory print in three or four seconds, or about as quickly as it can be switched on and off. The old process with a high candle-power incandescent lamp necessitated an exposure five times as long, and the prints were not so uniform.

A mercury vapour lamp has also effected a wonderful saving in making enlargements. This lamp consists of four mercury tubes in series on a 220-volt circuit. The time of exposure with this source of light as compared with a focusing carbon arc lamp using about 30 amperes is about in the ratio of 1 to 10, and the amount of power required with the mercury lamp is of course considerably lower.

A general idea of the company's photographic work may be gained from the statement that the department produced last year nearly 4000 negatives and 130,000 prints, exclusive of blue prints from drawings and diagrams printed on the electric machines in the drafting room.

A floor space of about 2600 square feet is utilized by the engraving and electrotyping departments, which employ the usual quota of men, including photographer, etcher, re-etcher, moulder, finisher, prover and blocker, in addition to a corps of photographic retouchers. The various machines are driven by individual motors, and in this respect, as well as in arrangement and management, the plant is a model one. The annual output, including half-tone plates, zinc etchings, electrotypes, etched brass and copper name plates, and master patterns for casting large name plates, is valued at more than $22,000.

Mercury vapour lamps designed for this department by the General Electric company's engineers are used almost exclusively in the studio with excellent results. Each lamp consists, as shown in Fig. 5, of five 18-inch mercury tubes in series on a 220-volt, direct-current circuit. The focusing carbon arc lamps formerly used required about 30 amperes, and two were used in series on 110 volts, whereas the two mercury lamps use less than 4.5 amperes each on 220 volts. Therefore, while the time of exposure is not materially reduced, the energy consumption is considerably less and a marked improvement

FIG. 8.—ANOTHER PART OF THE PRINTING DEPARTMENT, CONTAINING MOTOR-DRIVEN CYLINDER AND JOB PRESSES

is noticeable in the rendering of colour values as compared with the arc lamp, or even daylight.

Prints on metal are made by artificial light preparatory to etching, and for this process two 10,000-candle-power, focusing arc lamps in series on a 110-volt circuit are employed. They are shown in Fig. 4 and use about 60 amperes and produce prints in less time than bright summer sunlight. Thus, while the lamps consume a large amount of power, they are not extravagant because they are not required to burn for long periods.

The electrical equipment of this department also includes an electrically heated oven for drying lacquer and baking enamel, and a heating unit to immerse in solutions requiring heating.

The equipment of the printing department, part of which is shown in Figs. 6 and 8, includes eight cylinder presses for fine half-tone work, twelve job presses, a ruling machine, four cutting machines, an automatic envelope press which turns out 14,000 printed envelopes per hour, and two type-casting machines. Each

FIG. 9.—MOTOR-DRIVEN MANIFOLDING MACHINES

press is coupled to a General Electric printing-press motor controlled by the multiple unit system. The press may be started or stopped instantly by touching a conveniently located electric button at the feed board.

The working force of this department includes from 80 to 100 employees, and the value of a year's product, including catalogues, circulars, factory forms, stationery for the company's various factories and offices, amounts to about $200,000.

The composing room is lighted with enclosed arc lamps with concentric diffusers, and electric heating devices are being designed for melting metal for the type-casting machine.

Formal instructions are issued by the engineering department to the factory in three forms:—

Engineering notices, which are instructions applying to machines built on a specific customer's requisition.

Standing instructions, which apply to an entire line of machines.

Engineering briefs, or instructions not of a permanent nature and not applying to machines built on any particular requisition.

All these instructions are transmitted in typewritten form from the engineering department to the publication bureau, where wax stencils are prepared for the manifolding machines shown in Fig. 9. These machines are separately driven by General Electric motors mounted under the table and controlled by means of small series rheostats. In addition to engineering instructions, they print shipping memoranda, circular letters, and miscellaneous forms. Four machines without crowding produce 10,000 copies per day. Engineering instructions as they come from the machines are sorted and distributed to the factory through pneumatic tubes.

An important adjunct to the publication bureau is the factory library, shown in Fig. 1, which is a highly specialized department for electrical research. It includes the most important works of reference, and has on file all the leading technical papers for the use of the company's engineers.

The new electric locomotives supplied by the British Westinghouse Company to the Metropolitan Railway of London are equipped with four motors of 300 H. P. each, which, owing to the terminus facilities being somewhat restricted, are of a smaller size than usual so as to keep down the length of the locomotives to convenient limits. Forced ventilation is used to prevent the motors overheating.

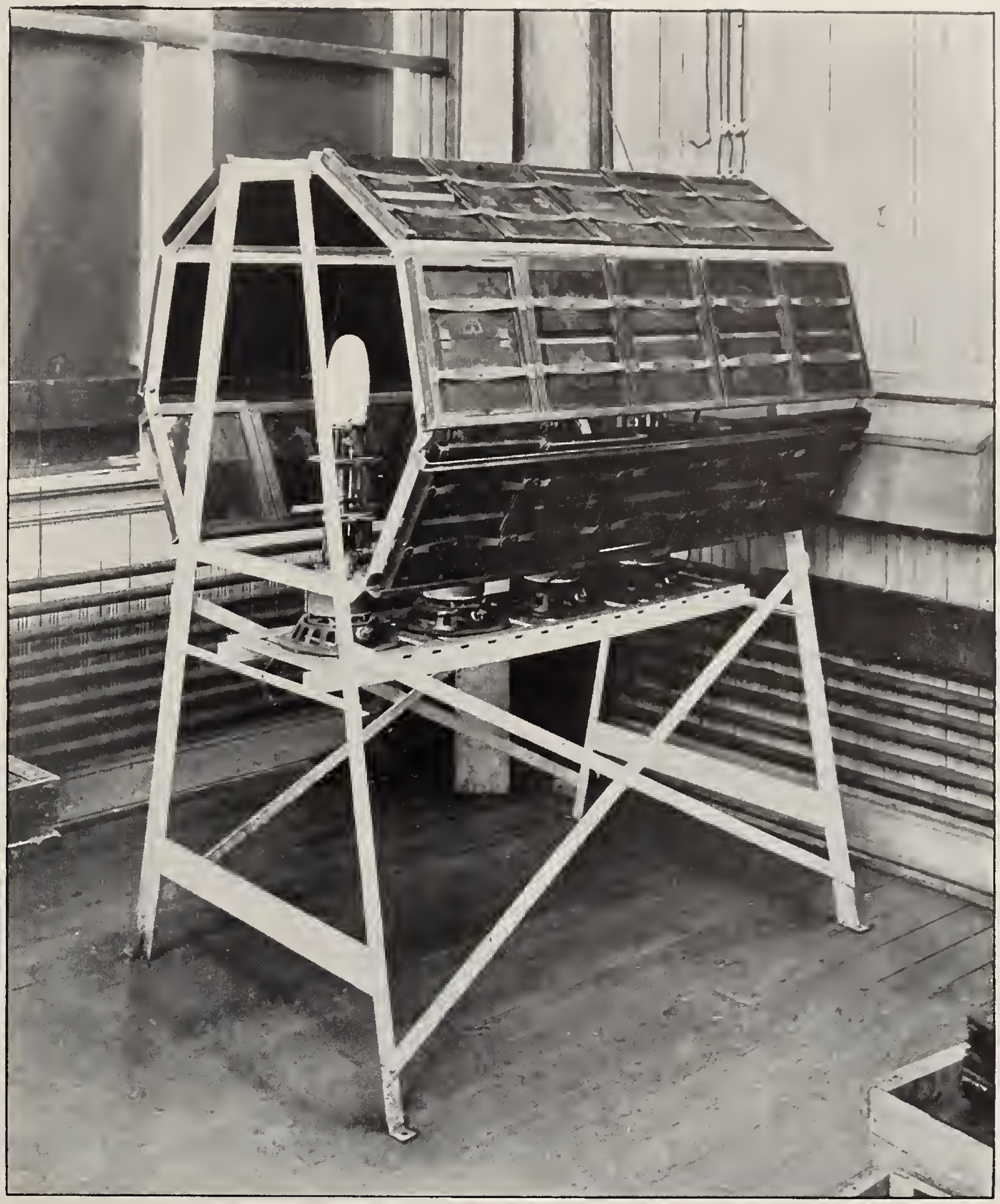


FIG. 10.—A FRAME WITH ENCLOSED ARC LAMPS FOR PHOTOGRAPHIC PRINTING WITH GLASS NEGATIVES. THIS HAS A CAPACITY OF ABOUT 5000 8-INCH X 10-INCH BLUE PRINTS PER WEEK

A Great African Telegraph Line

IT is reported that the telegraph line which is to run from the Cape to Cairo, the length of the continent of Africa, has reached, from the south, Udshidshi, on the shores of the Tanganyika Lake, in German East Africa. A survey is now to be made to find the best connecting route with the north, and the line already established is to be examined and improved.

It is presumed that the communicating link will run along the east shore of the great Victoria Lake, thence in a northerly direction reach Rosares, at present the last telegraph station in the Soudan. Considerable difficulty will have to be overcome, as a swamp 100 miles in length exists north of Udshidshi, where it will be very difficult to run a reliable air line. It was intended to run around this swamp, but now it has been determined to utilize wireless telegraphy for communication across, which, however, will probably be only a temporary affair, as the wireless telegraph appears to be unreliable in the Tropics, and would also decrease the efficiency of the great trans-African telegraph line.

The New York legislative committee appointed to investigate electric towing systems for canal use has reported that it is not now advisable to recommend any system because the improvements to the Erie Canal will not be completed for several years. Tests on the Erie Canal at Schenectady, by the International Towing & Power Company, convinced the committee that such a system may be used advantageously for a considerable portion of the enlarged canal.

All the vessels of the Cunard Steamship Company are to be provided with submarine sound signaling apparatus.

Niagara Power in New York

By ALTON D. ADAMS

NEW York City will see Lake Erie water displace Pennsylvania coal within a decade. This must be because the great cataract develops power more cheaply than any steam plant, and electric energy is transmitted over wires at a cost below the charge of the railways for carrying coal.

At this time the prospect for Niagara power in New York is much increased by the certainty that the great generating plants now under construction at the Falls cannot find a nearer profitable market. Electric generating plants now either completed or in process of construction at Niagara Falls have a combined capacity of more than 600,000 H. P. Judging by the experience of the last ten years, it is hard to believe that the amount of power just named can find application within one hundred miles of the Falls during the next half century.

The first generators of the Niagara Falls Power Company, whose two plants of 105,000 electric H. P. capacity are the largest of those now in operation, began commercial service in October, 1895. In March, 1897, the local distribution of the company just named amounted to about 7730 H. P., and less than 2000 H. P. was transmitted to Buffalo, 23 miles distant, by the line (XVIII A. I. E. E. 497,505). Near the end of 1904 the maximum load on the lines of this company was less than 90,000 H. P., and of this fully one-third was transmitted to Buffalo.

Thus, in substantially a decade it has been possible to build up an electric load of less than 100,000 H. P. on these new Niagara plants, and about one-third of the demand has come from Buffalo, the largest city nearer than New York or Philadelphia. Even this amount of power has been sold only by making rates that have shut down every stationary steam engine in the city of Niagara Falls, and have built up a motor load of more than 18,000 H. P. in the manufacturing plants of Buffalo, besides substituting water for steam power in the lighting and electric railway systems of these cities.

If, then, it has taken a decade to build up a load of 100,000 H. P., and this has been done only by supplying the demands of cities that have an aggregate population of fully one-half a million persons, how long will it take to sell 500,000 H. P. more in that locality? Only a small part of this power can be sold in Canada. Hamilton already has most of its factories operated by electric energy that is generated with water drawn from Lake Erie by way of the Welland Canal. Toronto can absorb some power, but the line now under construction for the delivery of 20,000 H. P. in that city will apparently meet its requirements for a long time to come.

Cleveland, Rochester and Syracuse may also take some energy, but it is improbable that any one of them will use as much as Buffalo. Troy, Albany and Schenectady already have cheap electric current from two large water-power plants on the Hudson. Detroit and Pittsburgh might each utilize very respectable amounts of electric water power, but fuel is very cheap at the latter city, and it is quite possible that the State of New York might object to the transmission of large blocks of Niagara power beyond its limits. Electrification of the steam railways about Buffalo would consume a large amount of power, but only a fraction of the great prospective supply. It certainly is a fair inference from the experience at Niagara Falls that the local increase in the use of electric energy there must go on by thousands rather than by tens of thousands and hundreds of thousands of horse-power.

New York City, of all possible markets for Niagara power, offers the greatest demand at paying rates. During 1904, the larger of the electric light companies operating in the borough of Manhattan generated 136,084,451 KW., and the smaller company there sold to consumers 14,349,707 KW.-hours, so that it generated about 20,000,000 KW.-hours, on the fair assumption that 70 per cent. of the energy generated was sold. In the borough of Brooklyn the combined companies generated 51,279,606 KW.-hours for light and power purposes. The total energy generated by the lighting companies in these two boroughs was thus about 234,364,057 KW.-hours for the year, and this output might be supplied by a plant of about 27,000-KW. capacity working continuously at full load during the 8760 hours of the year.

In practical operation, however, a much larger plant would be necessary so as to provide some reserve capacity, and to compensate for the fact that the average load of an electric light and power station is far below its maximum load. Assuming a large day load of stationary motors, such as is known to exist in New York, the average 24-hour load may be taken at approximately 40 per cent. of the maximum load, which on this basis amounts to 27,000 $\div$ 0.4 $=$ 67,500 KW. for the two main boroughs of Greater New York.

Between generators at Niagara Falls and the transforming apparatus of sub-stations at New York a transmission efficiency of 80 per cent. can fairly be assumed. In order to deliver 67,500 KW. at such sub-stations with this efficiency of transmission the generating capacity of the Niagara Falls plant must be 67,500 $\div$ 0.8, or about 85,000 KW. The addition of 20 per cent. to this capacity in generators, to ensure reliability of operation, brings the rating of the necessary Niagara plant up to 102,000 KW., or 136,000 electric horse-power, for the operation of electric lamps and stationary motors in Manhattan and Brooklyn. Electric railways no doubt require a greater maximum capacity for their operation than do lamps and stationary motors in New York, but even if the demands of traction are only equal to those of the general electric supply systems, the operation of both would require generators rated at 272,000 H. P. in Niagara plants.

During the year ending June 30, 1904, the Niagara Falls Power Company derived a gross income of $1,126,423 from sales of energy generated in its two plants of a combined capacity of 105,000 electric horse-power. There is good reason to think that the average output of these plants during the 8760 hours of the year just named was fully 40,000 KW., amounting to 350,400,000

KW.-hours. If this is so, the average price received by the company for its output was only 0.32 cent per kilowatt-hour.

The larger of the electric supply systems in the borough of Manhattan generated 163,084,451-K. W. hours during 1904, as before stated, and the resulting cost to this system was 0.95 cent per kilowatt-hour on an average. This cost of current generated includes merely the fuel, labour and repairs at the power stations, and one-half of the taxes paid on the entire electric system. In this station cost of 0.95 cent per kilowatt-hour for current generated, there is no allowance for depreciation, though this is as much a part of the cost of operation as is the fuel; neither is there any allowance for the general expenses of the company, such as the salaries of officers, including those of the designing and supervising engineers.

While this 0.95 cent per kilowatt-hour is thus evidently somewhat below the actual cost of generating current in the largest electric supply system of New York, it is almost three times the approximate amount of 0.32 cent per kilowatt-hour that the Niagara Falls Power Company received for its output in the same year. It is only fair to assume that this approximate earning of 0.32 cent per kilowatt-hour of output is one which would be very acceptable for the great plants now nearing completion at Niagara Falls, since it is the figure at which existing plants are selling energy in the face of very little competition.

There now remains the question whether the difference between 0.32 cent and 0.95 cent per kilowatt-hour is great enough to warrant the transmission of energy from Niagara Falls to New York City. For the determination of this question it is only necessary to consider the cost of erecting and operating a transmission-line between Niagara Falls and New York, without regard to the cost of generating stations at the one end, or of receiving stations at the other. That this is so may be seen from the fact that the average price of 0.32 cent per kilowatt-hour is obtained for energy, a large part of which is stepped-up to a high voltage for transmission from Niagara Falls to Buffalo, and from the further fact that about 80 per cent. of the current generated in New York City at the cost of 0.95 cent per kilowatt-hour has to be both transformed and converted at substations before it can be distributed to consumers.

It is of course easy to show by direct computation, independently of any existing system, the amount of materials necessary to construct a line for the transmission of electric energy at any given rate from Niagara Falls to New York City, but such a computation lacks something of the force of a conclusion based on a concrete case. For this reason it may be well to demonstrate the cost of transmission lines between Niagara Falls and New York by reference to existing lines between Niagara Falls and Buffalo.

Between the generating stations of the Niagara Falls Power Company, and the terminal house where the Niagara power is received in Buffalo, there are three transmission circuits, each of which is designed to deliver 10,000 electric horse-power in that city with a loss of about 6 per cent. Each of these circuits carries three-phase, 25-cycle current at about 22,000 volts. Two of these circuits have a common length of about 23 miles, and each of these two is made up of three copper cables with an individual cross-section of 350,000 circular mils. By the route of the third and latest circuit the distance between the generating stations at Niagara Falls and the terminal house in Buffalo is only 20 miles, and each of the three conductors of this circuit has a cross-section of 500,000 circular mils.

Aluminum cables make up the third circuit, and the electric conductivity of each is therefore equivalent to that of a copper cable with a cross-section of 500,000 $\times$ 0.6, or 300,000 circular mils. This smaller equivalent cross-section of the cables in the aluminum circuit just about offsets their shorter length, so that the conductivity is almost exactly the same as that of each of the copper circuits.

With this 20-mile circuit operating at 22,000 volts and delivering 10,000 electric horse-power with 6 per cent. loss as a basis, what must be the size of conductors to deliver energy at an equal rate in New York from the power plants about Niagara Falls?

As the crow flies it is a little more than 300 miles from Niagara Falls to Manhattan Island, but to allow for some necessary deviations from a straight course, and to keep the line entirely within the State of New York, the length of a transmission circuit between these points may fairly be taken as 350 miles. This is a somewhat greater distance than electric power has ever been transmitted for commercial purposes. On the other hand, it is well known that the greater the amount of power to be transmitted, the longer is it practicable to make the same. And nowhere in the United States, save to New York and perhaps Philadelphia, as far as has been suggested, is it possible to transmit 100,000 to 200,000 H. P. from a water fall and find a profitable market over a line 350 miles long. This length is greater by only 50 per cent. than the line from De Sabla power house to Sausalito, Cal., 232 miles, which delivers perhaps 10,000 H. P. to a number of cities about San Francisco Bay.

How high it will ultimately be practicable to carry the voltage of transmission circuits is as yet mere matter of speculation. Nobody knows. It is perfectly well known that if it were practicable to increase the voltage directly with the distance, then the line 350 miles long would require no more copper than the one 20 miles long, both operating with 1100 volts per mile and the same total power and loss. But this abstract law is more curious than useful, in the present case, since there would be no object in creating an electric Frankenstein which nobody could control.

In the suggestions here it is the intent to keep within the present limits of electric practice, save only as to length of line. Voltage limits as fixed by regular operation on transmission lines are about 60,000. This is the voltage at which the line from Electra power house to San Francisco, 147 miles, and from Colgate power house to Oakland, 142 miles, have been operated. On the 65-mile line from Canon Ferry to Butte, Mont., the pressure of 55,000 volts is in regular use, and the same is true of the 83-mile line between Shawinigan Falls and Montreal.

From the fundamental formula for the cross-section of the conductors in electric circuits, it can be shown that for a given power and loss the cross-section of each conductor remains constant if its length varies with the square of the ratio between any two voltages of transmission. Thus, to state a particular case, if, on a transmission line in which the power and loss are constant, the voltage is doubled, then the length of the line must be multiplied by four, if the cross-section of each conductor is to remain the same.

Taking the 20-mile circuit operating at 22,000 volts between Niagara Falls and Buffalo as a basis, and assuming the use of 60,000 volts on a line from Niagara Falls to New York City, the ratio of the larger to the smaller voltage is 2.727. It follows from the law above stated, that for

equal power and loss on the 22,000-volt line and the 60,000-volt line, the latter must be extended to a length of 2.727 × 20, or about 150 miles, if the same size of conductors is used in each circuit.

When it is delivering 10,000 electric horse-power at Buffalo, the loss in the 20-mile circuit from Niagara Falls is 6 per cent., but it would not be economical to design a line 350 miles long for nearly so low a percentage of loss, because the annual saving of interest and depreciation charges on conductors by their design for a larger loss would more than offset the value of the additional energy dissipated as heat. As just shown, if a 10,000-H. P. circuit, with a 6 per cent. loss and a voltage of 22,000, has its voltage raised to 60,000, the length may be increased to 150 miles with the same size of conductors, for the same power and loss.

It follows directly from the formula for the cross-section of conductors in an electric circuit, that the percentage of loss in a circuit varies directly as its length, when all other factors including the size of conductors are constant. The 10,000-H. P., 60,000-volt circuit may thus be lengthened from 150 to 350 miles with the same size of conductors, if the percentage of loss is multiplied by 350 ÷ 150 = 2.333, thus raising it from 6 to 14 per cent.

It has thus been shown that the same size of conductors now used in a circuit to transmit 10,000 electric horse-power from Niagara Falls to Buffalo, at 22,000 volts, may be adopted for the transmission of an equal amount of power from these Falls to New York City, if the voltage is raised to 60,000 and the loss from 6 to 14 per cent. The three conductors of the 60,000-volt, 350-mile circuit between Niagara Falls and New York may each be of aluminum with a cross-section of 500,000 circular mils, or of copper with a cross-section of 300,000 circular mils, for the same conductivity. Each copper conductor of 300,000 circular mils has a weight of very nearly 5000 pounds, or 2.5 tons per mile, so that 350 miles of such cable weigh 875 tons, and the weight of the three cables to form the 10,000-H. P. circuit is 2625 tons.

At 15 cents per pound, copper wire costs $300 per ton, and the investment in the 2625 tons of cable would be $787,500 on this basis. To erect poles, cross-arms, pins and insulators, and to string the cables thereon, from Niagara Falls to New York, would cost $1000 per mile, or $350,000 in all, on the basis of market prices for materials and a fair allowance for right of way. This raises the entire cost of the transmission line for 10,000-H. P. to $1,137,500. As two-thirds of the cost of this line is represented by the investment in copper wire that has no insulation, the total annual charge for maintenance, depreciation and interest should not be more than 10 per cent. of the entire line investment, or $113,750 yearly.

If operated continuously at its full designed capacity of 10,000 H. P., the transmission line would deliver 8760 × 10,000, or 87,600,000-H. P. hours of electric energy at New York per year. The cost of transmitting this energy, in terms of the maintenance, depreciation and interest charges against the line, is thus 11,375,000 ÷ 87,600,000 or 0.13 cent per horse-power-hour, or 0.13 × 0.746 = 0.174 cent per kilowatt-hour, for constant delivery of full line capacity.

In Greater New York there is perhaps no time of day or night when the total electric load of lamps and stationary and traction motors does not reach 10,000 H. P. With a transmission of water power great enough to supply a large part of the demands for electric current in New York, the average 24-hour load would probably be as much as 50 per cent. of the maximum on the transmission lines. An average load equal to 50 per cent. of the maximum on transmission lines would raise the maintenance, depreciation and interest charges on line investmet to 0.174 × 2 = 0.348 cent per kilowatt-hour delivered.

With a maximum line loss of 14 per cent., and an average load equal to 50 per cent. of the maximum, the average loss would be not far from 10 per cent. If each kilowatt-hour delivered to the line at Niagara Falls cost 0.32 cent, then with an average loss of 10 per cent. each kilowatt-hour delivered in the sub-station at New York would cost 0.32 ÷ 0.9 = 0.355 cent for energy. This energy cost, plus the 0.348 cent per kilowatt-hour for charges against the transmission line, raises the total cost of energy delivered at the sub-station in New York to 0.703 per kilowatt-hour. Compared with the figure of 0.95 cent per kilowatt-hour, which it now costs the largest system on Manhattan to generate electric energy, the transmitted water power saves nearly 0.25 cent per unit. In other words, on this showing, Niagara power, if transmitted to New York and sold at what it costs the largest electric supply system there to make it, would bring a price greater by 0.25 ÷ 0.355 = 70 per cent. than that obtained at Niagara Falls, besides paying all charges against the transmission line.

Tests of a Curtis Steam Turbine Generating Unit

TESTS of a 2000-K. W. Curtis steam turbine generating unit were recently made by Frederick Sargent and Louis A. Ferguson at the works of the General Electric Company, at Schenectady, N. Y.

The turbine was a four-stage machine, designed in 1903 and recently changed in a few particulars as a result of experiments conducted during the past year. It conformed, as nearly as possible, to the standard four-stage machines now being produced, but was less efficient, since the changes made were confined to the buckets, while several important changes, known to be desirable, could not be made without entirely rebuilding the machine.

Several preliminary trials were made and the results of each of these very closely approximated the results of the official tests. All the instruments were carefully tested and standardized during the trials, the electrical instruments being tested by the New York Testing Laboratory. The surface condenser showed practically no leakage. Every precaution was taken to make the tests reliable and accurate.

The results were as follows:—

FULL-LOAD TEST

Duration of test	1.25 hours
Steam pressure (gauge)	166.3 pounds
Back pressure (absolute)	1.49 ins. of mercury
Superheat	307 degrees F.
Load in kilowatts	023.7
Steam consumption per KW.-hour	15.02 pounds

HALF-LOAD TEST

Duration of test	0.916 hours
Steam pressure (gauge)	170.2 pounds
Back pressure (absolute)	1.40 ins. of mercury
Superheat	120 degrees F.
Load in kilowatts	1066.7
Steam consumption per KW.-hour	16.31 pounds

QUARTER-LOAD TEST

Duration of test	1 hour
Steam pressure (gauge)	155.5 pounds
Back pressure (absolute)	1.45 ins. of mercury
Superheat	204 degrees F.
Load in kilowatts	555
Steam consumption per KW.-hour	18.09

ZERO LOAD

Duration of test	1.33 hours
Steam pressure	154.5 pounds
Back pressure (absolute)	1.85 ins. of mercury
Superheat	156 degrees F.
Steam consumption per hour	1510.5 pounds

In 1904, the production of carborundum amounted to 7,060,380 pounds. In 1903, it was 4,759,890. The production of artificial corundum, or alundum, as it is called, another abrasive made in the electric furnace, amounted to 4,020,000 pounds.

Artificial Illumination—III

By Dr. EDWIN JAMES HOUSTON

Continued from the July Number

THE HOLOPHANE SYSTEM

WHILE a shade covered on the surface exposed to the luminous source with some good diffusing substance, such as finely divided aluminium in the form of a paint, serves admirably for diffusing light for the purposes of artificial illumination, yet, as ordinarily constructed, it is unsuited for the lighting of such interiors as theaters, churches, drawing rooms, dining-rooms of hotels, etc.

Where, as in the case of ordinary machine shops, the work is practically the only object that is to be illumined, the diffusion shade admirably meets all requirements, since it

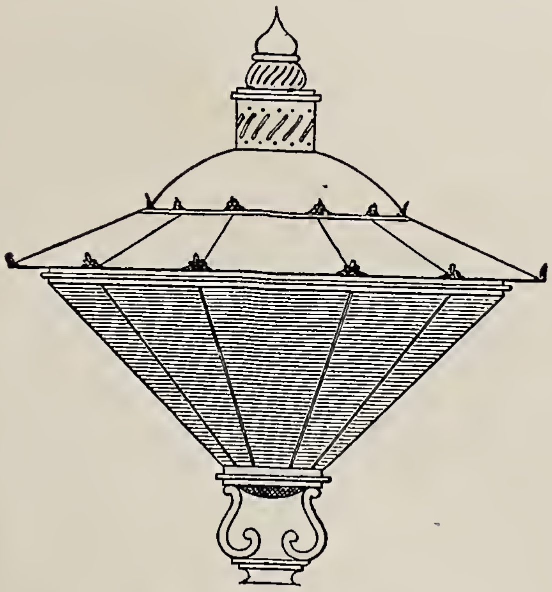


FIG. 12.—TROTTER'S EARLY FORM OF POLYGONAL LANTERN WITH RIBBED GLASS AND REFRACTING PRISMS

practically throws all the light on the work and, at the same time, prevents the entrance of any of the direct light from the source into the eyes of the workman. The shade being formed of opaque material, its outer surface receives no light except the small quantity that falls on it by secondary diffusion from surrounding objects, and consequently appears practically black. Such shades, therefore, except when placed near the corners of rooms or near ceilings, under proper conditions, are unsuited for purposes where it is not only necessary to thoroughly illumine the objects in the room, but where, at the same time, the sources of illumination are employed as prominent parts of the decorative features of the room.

It is by no means an easy problem readily to provide a source of artificial light with a diffusing or deflecting cover that can be employed safely for the illumination of the various objects in a room, and yet at the same time be capable of forming a part of its artistic decoration. For such purposes the source of light must necessarily be visible, and yet be so placed as to throw its light on the surrounding objects without, as far as possible, permitting too great a proportion of such light to directly enter the eyes.

While the employment of a considerable number of uncovered gas jets, incandescent electric lamps, or arc lights, serves fairly well for decorative purposes, yet when so used they should be placed at a sufficient distance above the floor of the room, as, for example, near the ceilings of high rooms, as will decrease the probability of the light directly entering the eyes. Unless this is carefully done, the use of such luminous sources is highly objectionable, since there is danger of their becoming practically the only conspicuous objects in the room. The eyes of the observer being attracted toward the sources of light, are so weakened by retinal fatigue as to be unable to properly view other objects in the room. Moreover, the use of uncovered sources of light is open to the objection of producing strongly marked shadows around all objects lying within the illumined space.

In order to avoid the difficulties here referred to, the plan is frequently adopted of protecting the eyes from the glare of the luminous sources, and softening their emitted light by covering them with globes formed of different varieties of semi-transparent or translucent materials, such as ground glass or opalescent glass. Where such materials prevent the direct passage of the light through the globe to such an extent as to prevent the source of light from being distinctly visible from the outside, the globe will emit a uniformly mellow light from all parts of its surface. Thus, to a certain extent, the eye is protected at least from the intense glare of the bare source of light, and good effects of surface illumination are insured.

Of course, it is evident that in such cases, since the sources of light are

FIG. 13.—PROFILE OF EXTERNAL PRISMS ON HOLOPHANE GLASS, AS USED FOR STREET LIGHTING WITH WELSBACH INCANDESCENT MANTLE BURNER. ACTUAL SIZE

visible, the light can directly enter the eyes of the observer, so that this method of illumination is bad from a physiological standpoint, although almost immeasurably superior to the direct illumination obtained by bare or uncovered luminous sources.

Many attempts have been made to provide globes for luminous sources that shall serve as efficient means for decreasing the intense glare produced by bare sources, and yet at the same time shall cause the rays from the luminous source to be deflected or thrown in a general downward direction so as to insure the illumination of objects placed below the luminous sources. Such methods of indirect illumination employ

FIG. 14.—THREE OF THE PRISMS IN FIG. 13, SHOWING THEIR SIZE AS DRAWN IN THE ORIGINAL CALCULATIONS

the principles of reflection or refraction, or depend for their operation on the combined effect of both reflection and refraction. One of the most successful of such plans is known as the system of holophane lighting.

The system of holophane indirect illumination is based on optical principles that have long been known to the scientific world; viz., that rays of light can readily be turned out of their course by refraction on passing from one medium to another of different density, and that the amount of such deflection can be readily increased by combining with refraction the principle of reflection at the bounding surface between the denser and the less dense medium,—or as it is generally called, the total internal reflection of the light. By a suitable combination of the principles of refraction and internal reflection, Blondel and Psaroudaki are able to obtain such an amount of change in the direction of light as it is emitted from a luminous source so as to cause such light to pass in whatever direction may be required.

The possibility of employing the refracting power of glass for improving the distribution of light from a candle or lamp was recognized from very early dates. In 1675, Richard Reeves took out letters patent in England for an invention which he styled, "The Arte of Casting and Spreading of Light by a new and unusual figure of foiled glass, polished without grinding, with pipes of glass for holding the candle or lamp." The specification of this patent does not describe the means by which the objects of the invention are to be obtained.

In 1684, Edward Wyndus took out letters patent in England for a complete system of prismatic glass globes. This patent is described by him as follows:—"The discovery of a new experiment for the great and durable increase of light by extraordinary glasses and lamps, for the great improvement of ship lanthornes, lighthouses, and dispersing of light in mines, and other necessary and like profitable uses which require light and heat." No description, however, is given of the means by which the globes or glasses are to be formed.

In 1857, Degrand took out British letters patent 553, for an invention entitled "Lenticular Glasses for Lighting and Reflection." In the language of the specification, the inventor remarks:—

"It is well known that, although glass corrugated, striated or waved, cannot be seen through, yet it emits light. It has, therefore, been used instead of blinds as a substitute for painted or ground glass. This sort of glass may be so made, and its waves, striæ or corrugations so formed, as to serve as powerful lenses or reflectors for lamps, lights, etc., and as mirrors; as the effect produced by these glasses upon the rays of light which penetrate or fall upon them, and the direction of the reflected or refracted light depends upon the form of the lens or glass, and upon the form of the waves or striæ upon its surface, the object of the present invention is to construct lenticular glasses of corrugated glass, and in forming the corrugations in

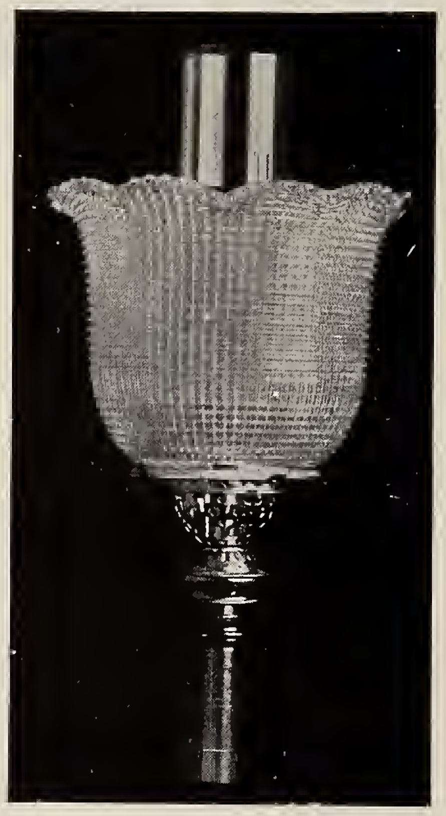


FIG. 15.—FORM OF HOLOPHANE GLOBE FOR WELSBACH MANTLE INCANDESCENT GAS LAMP

the glasses of such shape or shapes as may produce any required effect of refraction or reflection on light or heat.

"In the practical manufacture of these various striated lenticular glasses, two methods may be employed:—First, the ordinary casting process; second, stamping by means of dies or moulds, when the glass has been sufficiently softened by heat to allow it to receive under pressure the required impression. In either case, the first thing to be done is to make a mould precisely corresponding to the form which the glass is required to receive."

The inventor calls attention to the well-known Fresnel system of glasses employed for lighthouses and beacons, and claims as a part of his invention as follows:—

"I propose to substitute for this

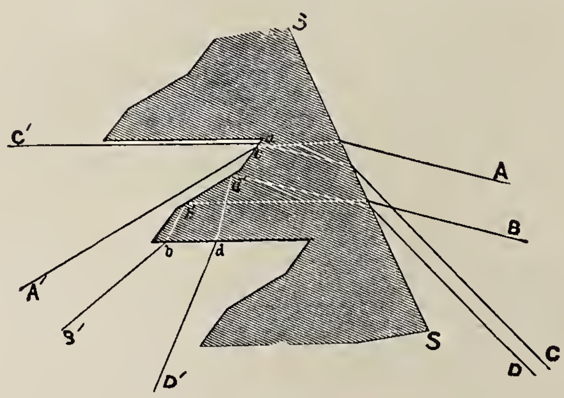


FIG. 16.—PATH OF RAYS SHOWING REFRACTION ONLY, AS WELL AS THE COMBINED EFFECTS OF REFLECTION AND REFRACTION

process my own mode of manufacturing striated glasses. By this method the glass is obtained either in one single piece, or in a very small number of pieces, at first cast, and afterwards the pieces are placed in the lathe merely to perfect their polish, in which latter process the layer of material which is removed is imperceptibly thin. These pieces, when cast, have a polish of their own, which may be improved by exposure to the heat of an active fire, so melting their surfaces."

The Degrand patent papers show carefully drawn figures of various forms of globes that are provided with differently shaped prismatic corrugations on the external surfaces, so arranged as to throw the light in the required direction.

The next one to employ well-known optical principles in the solution of the problem of the deflection of light by means of transparent mediums was A. P. Trotter. Here the deflecting medium consisted of a lantern formed of panels of glass provided with vertical ribbings on the inside for producing diffusion, and horizontal ribbings on the outside for improving the distribution. Trotter employed his device on lamp posts for the purpose of insuring uniform illumination on a horizontal plane over a circle having a diameter of about seven times the height of the lantern above the pavement. This was insured by the use of refracting prisms based on the well-known Fresnel principle. It appears that Trotter employed refraction only for insuring the distribution of the light. Fig. 12 represents the general appearance of the Trotter polygonal lantern provided with reflector and ribbed glass.

At a later date, another inventor, Fredureau, employed a globe having external horizontal prisms that insure the scattering of the light by reflection only. Blondel and Psaroudaki differed from the two patents just referred to in that they employed a combination of refraction and internal reflection.

Before, however, the date of the Blondel and Psaroudaki patent, i. e., July 4, 1896, a British patent, 181, of roof lamps for railway carriages, described a method whereby the light of the lamp, prevented from being lost on the ceiling of the car, was thrown into the space below a horizontal plane passing through the center of the lamp by the principle of refraction and reflection. This will be seen from the following quotation from the specification:—

"This invention has for its object improvements in roof lamps, especially useful for railway carriages, and consists in the combination of cylindrical glass lenses and prisms surrounding the flame of the lamp, and so arranged as to condense and

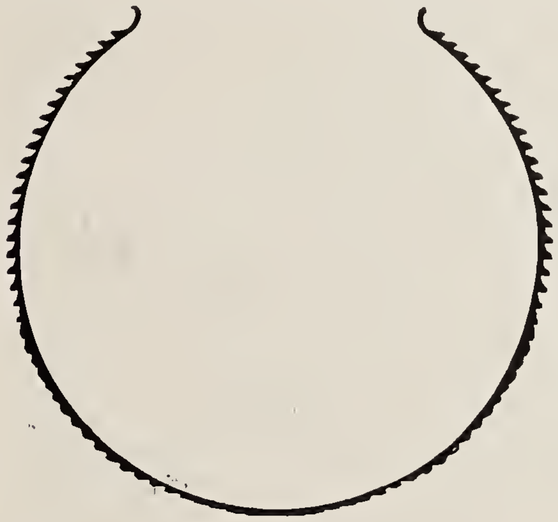


FIG. 17.—PROFILE OF EXTERIOR PRISMS ON A 5-INCH HOLOPHANE GLOBE, SUITABLE FOR USE WITH A 16-CANDLE POWER INCANDESCENT ELECTRIC LAMP

deflect by refraction and reflection, or by either of these agents, the light now usually wasted on the ceiling and the upper parts of the compartments of carriages, for the convenience and comfort of passengers occupying the same."

"The lenses and prisms are so arranged as to form part of the glass or basin usually attached to railway carriage roof-lamps, or the lenses and prisms may be made to surround and enclose the said glass basin; or, in some cases, the usual glass basin may be surrounded by lenses and prisms for the purposes set forth."

In this particular case both ordinary metallic reflection as well as the total internal reflection by a part of the glass prism is employed for the deflection of the light downward.

The holophane system of illumination is based on United States letters patent 563,836 and other patents to Blondel and Psaroudaki. In United States patent 563,836, for a lamp globe, the invention is described as follows:—

"Our globes are made of clear glass or crystal, and are so moulded with prisms upon their exterior and interior as to refract and reflect the light passing through them, prevent its absorption, and direct its rays in any desired manner.

"One of the primary objects of our globe is that the rays of light passing through it, while not being reduced in intensity or lost by reflection, shall be broken up and diverted in all directions so as to give the exterior surface of the globe a luminous appearance over its entire surface. In consequence of this peculiar luminosity, we have called the globes 'holophane,'—that is, 'entirely shining,' or uniformly luminous. In this particular they are peculiar, having great beauty as well as illuminating power.

"A portion of our globes in some cases may be moulded with a system of triangular prisms upon the exterior, which are so related to those on the interior as to produce a total reflection of light, thus throwing the light back upon the globe and out through any desired portion thereof without its loss in an undesired direction.

"Our globes are constructed by moulding transparent glass into any desired form, having vertical and vertical-meridianal flutings on the inner surface, and horizontal parallel flutings or fluted rings on the outer surface. These flutings produce prisms on the inner and outer surfaces, said prisms having faces, the angles and dimensions of which

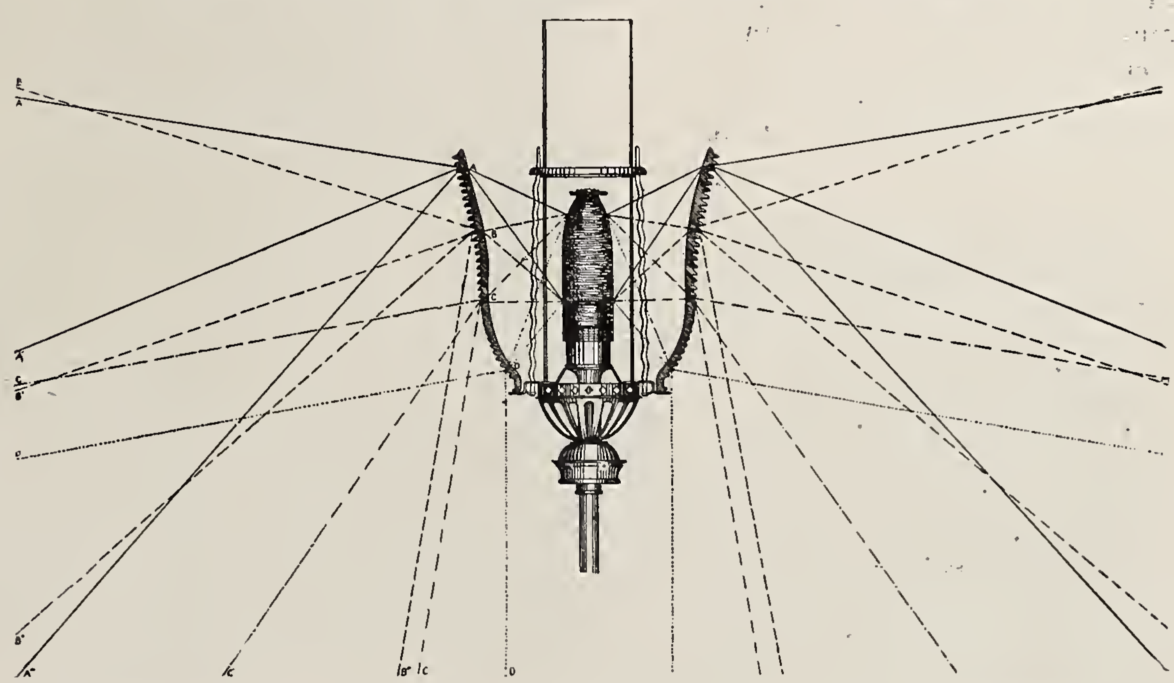


FIG. 18.—SECTION OF HOLOPHANE GLOBE SURROUNDING A WELSBACH INCANDESCENT MANTLE LAMP, SHOWING DISTRIBUTION OF THE LIGHT

are calculated and moulded in a manner which will be hereinafter explained."

A large portion of the patent specification is taken up with calculations as to the straight or curved shapes which must be given to the faces of the prisms on the exterior of the globes in order to obtain the distribution of light in the direction that may be desired. These calculations are, as stated in the specification, made in accordance with well-known mathematical laws.

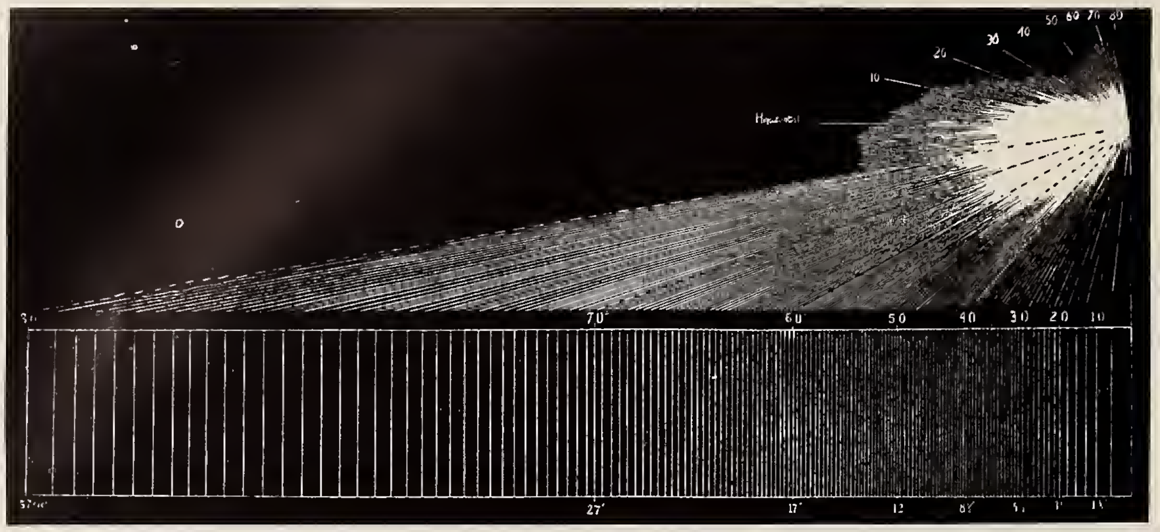


FIG. 19.—DISTRIBUTION OF LIGHT EFFECTED BY A WELSBACH INCANDESCENT MANTLE GAS LAMP COVERED BY A HOLOPHANE GLOBE

As will be seen, in the Blondel and Psaroudaki system, a globe, the outlines of which vary with the general shape of the luminous source, is placed around the source. This globe is formed of transparent glass, the surfaces of which are so shaped as to throw the light by means of refraction and total internal reflection in the desired directions. In some forms of these globes the inner surface is smooth and the outer surface is furnished with rows of prismatic rings, the inclinations of which are so varied as to cause the rays of light from the luminous source to be so turned out of their course by refraction, or by refraction combined with internal reflection, as to take the desired direction.

Fig. 13 represents the profile of the external prism on a holophane globe intended for use with the Welsbach incandescent lamp. Here, as will be seen, the inclination of the separate grooves that form the prismatic rings varies from point to point so that the varying angles of incidence which with the light from the Welsbach mantle strikes the surface of the globe is such as will insure the necessary deflection of the rays. In Fig. 14 a magnified view is given of the inclination of a portion of these grooves. From this will be seen the general shape of the prismatic rings that form such grooves. The general appearance of a somewhat similar holophane globe is represented in Fig. 15. Here, as can readily be seen, there are two separate sets of vertical and horizontal groovings intersecting one another at right angles.

The principle of operation of the Blondel and Psaroudaki system of holophane illumination will be better understood from an examination of Fig. 16, which represents in cross section both the action of the prisms on different rays of light, as regards refraction only, as well as the combined effects of refraction and reflection.

Here four separate rays only, *A*, *B*, *C* and *D*, are represented as having come from an inclosed Welsbach incandescent gas lamp mantle. The ray *A* is parallel to the ray *B*, and the ray *C* is parallel to the ray *D*. Of these rays, however, *A* and *C* are turned out of their course by refraction only, both while entering and leaving the glass prisms, while the rays *C* and *D* undergo refraction on entering the prisms, total internal reflection from the face of the prisms, as well as an additional refraction on leaving the prisms.

Following the path the rays take during their passage through the glass globe and after their emergence into the space outside the globe, it will be seen that the ray *A* strikes the interior surface *SS* of the globe, undergoing refraction both at the point of incidence in the denser medium as well as at the point of emergence *c* in the space outside the globe, the emergent ray taking the direction *cA'*.

The ray *B*, striking the inner face of the globe at the same angle of incidence as the ray *A*, undergoes the same amount of refraction at the incident surface, and passes through the glass in a direction parallel to that taken by the ray *A*. The ray *B*, however, instead of striking the face of the prism lying near the outer surface of the globe at the same angle of incidence as the ray *A*, strikes it below this point, that is, at *b'*, so that its angle of inclination with the face is such that it is unable to emerge and undergoes total internal reflection, taking the path *d'd* and suffering refraction on leaving the medium, takes the final path *bB'*.

The ray *C*, coming from a point of the incandescent mantle below the rays *A* and *B*, strikes the inner surface *SS* of the prismatic ring in the position shown, and suffering refraction on its passage through the glass emerges at the point *a*, again undergoing refraction and taking the direction *aC'*. The ray *D*, parallel to the ray *C*, undergoes refraction on enter-

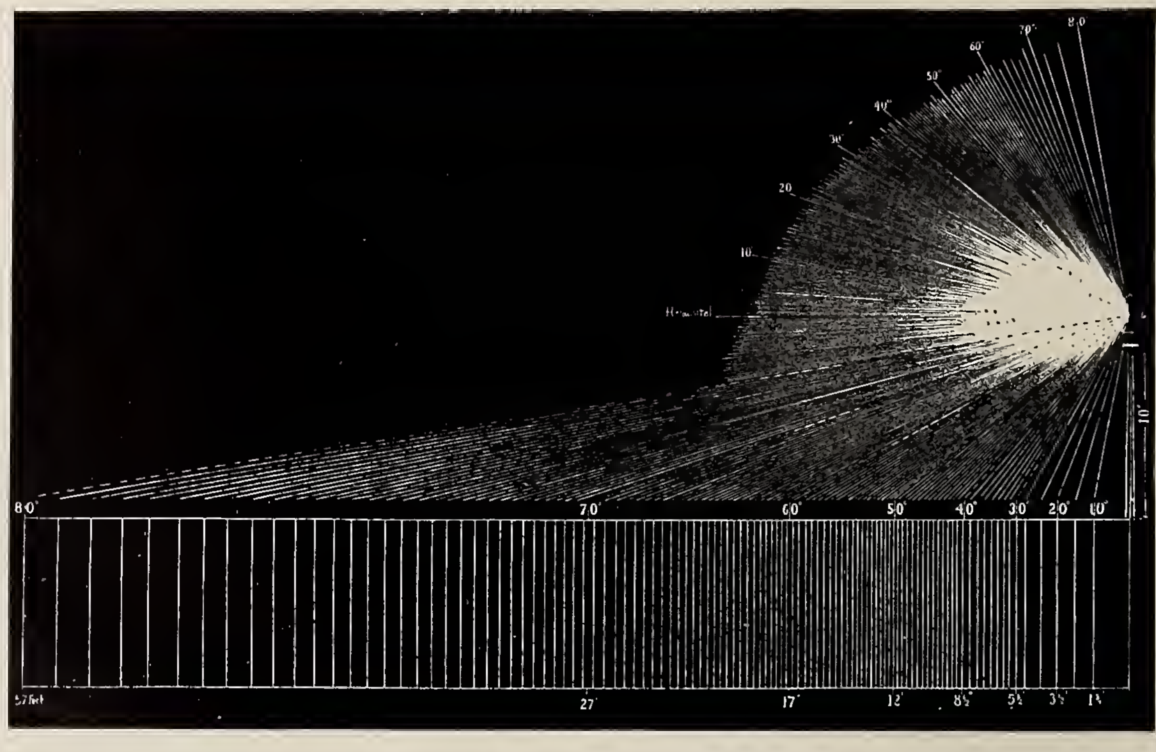


FIG. 20.—DISTRIBUTION OF LIGHT EFFECTED BY A BARE WELSBACH INCANDESCENT MANTLE GAS LAMP

ing the prismatic ring at a point on the surface SS, passes parallel to the direction of the ray C through the prism, and undergoes total internal reflection at the point D', emerging at the point d where it again undergoes refraction in the direction dD'.

As will be seen from an inspection of Fig. 16, all four rays, A, B, C and D, without the action of the prismatic shade, would have passed above a horizontal plane through the center of the luminous source, and would therefore have failed to contribute any of their light to the space below the lamp; but, by means of their refraction or by the combination of refraction and internal reflection, all have been deflected below this horizontal plane. In a similar manner, rays of light from various parts of the luminous source are so

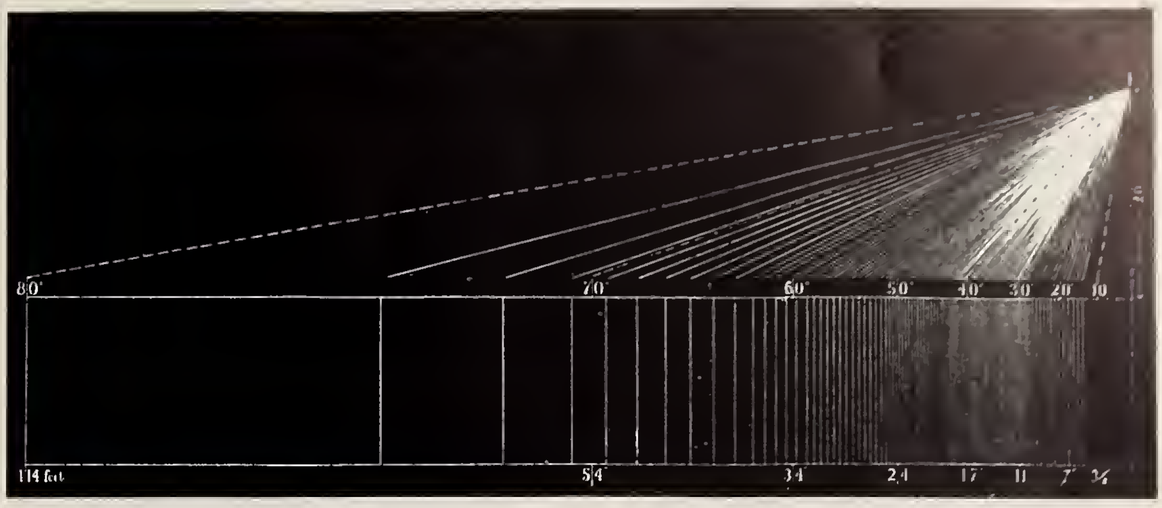


FIG. 22.—DISTRIBUTION OF LIGHT FROM A BARE CONTINUOUS-CURRENT ARC LAMP, WITHOUT A GLOBE, 20 FEET ABOVE THE PAVEMENT

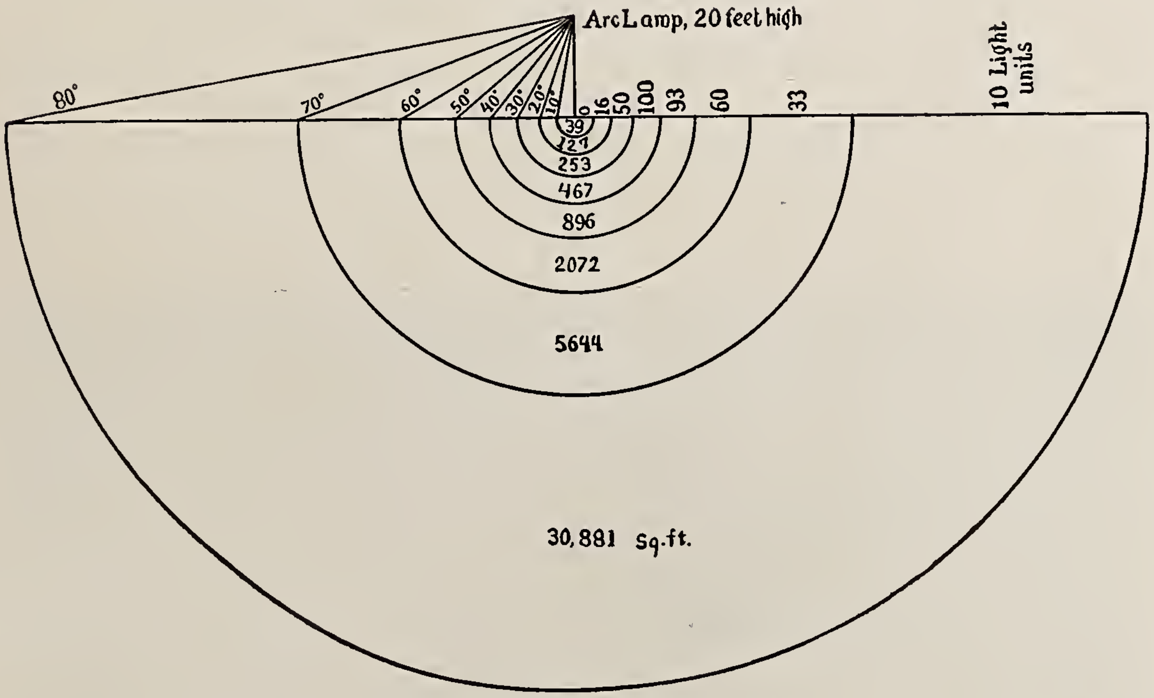


FIG. 21.—DIAGRAM SHOWING THE SQUARE FEET OF SURFACE COVERED BY LIGHT EMITTED WITHIN ANGLES OF 10 DEGREES, AND THE NUMBER OF LIGHT UNITS FALLING ON EACH SURFACE, FROM A BARE ARC LAMP 20 FEET HIGH

deflected as to nearly all be thrown into the space below the horizontal plane. This can readily be seen from an examination of Fig. 18, where, however, only a few of the rays are represented so as to make it easier to trace their directions through the prismatic ring.

It is evident that by properly proportioning the inclination of the different external surfaces of the prismatic rings, the rays of light from any part of the lamp can be made to pass generally below the horizontal plane extending through the center of the luminous source.

The general appearance of a holophane globe will necessarily vary with the shape of the luminous source around which it is placed. For example, in the case of an incandescent lamp, the lamp would be placed with its base pointing upwards. In this case the globe can be made to completely surround the lamp, except so far as its base is concerned. The general appearance of the globe employed for this purpose is represented in Fig. 17.

The outlines of the prismatic rings will necessarily be dependent on the shape of the incandescent filament.

There can be no doubt that the system for deflecting the light from any luminous source by the employment of holophane globes is capable of being extremely efficient for the following reasons:—

(1) By properly proportioning the angles of inclination between the faces of the external prisms, advantage can be taken of the turning of a ray out of its course either by refraction alone, or by the combination of refraction and total internal reflection.

(2) Since the prisms are made by the well-known process of moulding or pressing, the glass can be made thin so that the amount of light lost by its passage through the prism is comparatively small. There is not the necessity, generally speaking, that exists in the construction of the well-known dioptric glasses that are employed for lighthouse illumination, to make the prisms of sufficient thickness to permit them to be subjected to the ordinary operation of cutting and grinding in the lathe.

(3) That where the moulding or stamping process is employed, any number of globes can be readily duplicated in which the refracting angles will rigorously be those for which the mould was cut.

It will be interesting to inquire as to the extent to which it is possible to obtain the requisite de-

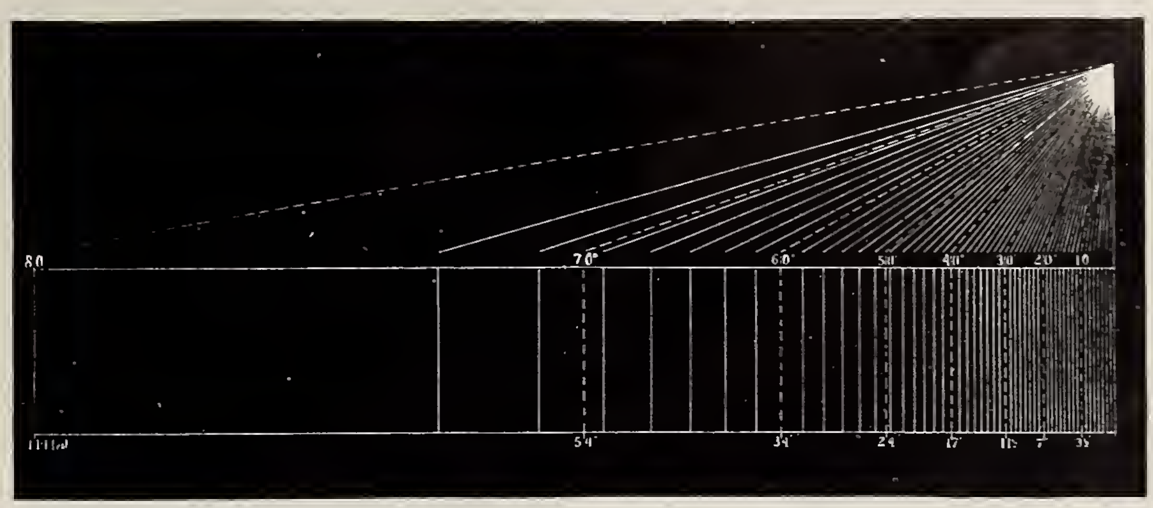


FIG. 23.—DISTRIBUTION OF LIGHT FROM AN ARC LAMP USED WITH AN OPAL GLOBE

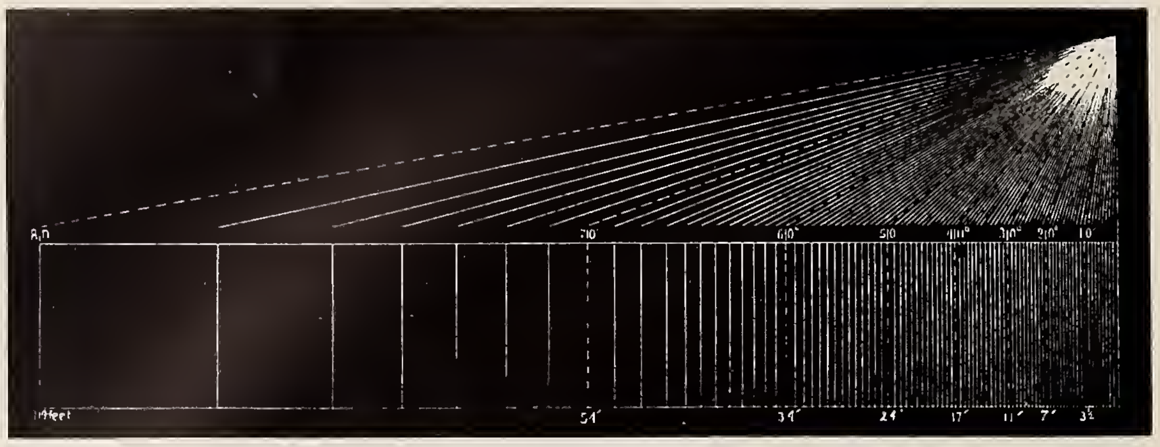


FIG. 24.—DISTRIBUTION OF LIGHT FROM AN ARC LAMP COVERED WITH A HOLOPHANE GLOBE

gree of deflection of the rays from any luminous source employing globes of this character.

The distributing effect produced in the case of an ordinary Welsbach incandescent lamp is represented in Fig. 20. Here the lamp is bare, or is unprovided with any globe. Fig. 19 represents the effect produced by surrounding the Welsbach lamp represented in Fig. 20 with a holophane.

In both Figs. 19 and 20, the areas surrounding the luminous source are divided into regions by means of dotted lines 10 degrees apart. The full lines represent the varying amounts of light that are emitted by the lamp within each of these angular spaces. As will be seen, considerable light passes above the horizontal plane in the case of the bare globe in Fig. 20, and indeed, even in the case of the globe covered by a holophane, Fig. 19, yet not only is the amount of light lost much less in the case where the holophane globe is employed, but, as will be seen, the uniformity of distribution in the space below the lamp is much greater than where the lamp is provided with a bare chimney only.

In a similar manner the distribution of light from a bare arc lamp—i. e., an arc lamp that is covered only with a globe of clear glass—is represented in Fig. 21.

This diagram was drawn from data furnished by M. Andre Blondel, Consulting Engineer of the Lighting Department of the French Republic. Here are marked the relative amounts of light falling on angular spaces taken 10 degrees apart. It will be seen that about one-half of the light falls within the angular spaces between 30 degrees and 50 degrees, containing $467 + 896 = 1363$ square feet, while only about 3 per cent. of the light is included in the outer surface of 30,881 square feet.

Fig. 22 represents diagrammatically the distribution of light from a continuous-current bare arc lamp suspended 20 feet above the street. In Fig. 23, the distribution of light from the same arc lamp is shown when covered with a globe of opal glass.

In Fig. 24 is shown the light emitted from this lamp when covered with a holophane globe. An examination of these diagrams will show that while there is a loss of considerable light in the case of the diffusion globes, yet the uniformity of distribution is much greater in the case of the opal globe than in the case of the bare globe, and is best of all in the case of the holophane globe.

Fig. 25 represents the gain obtained in the deflection of the light of the Welsbach incandescent lamp in the space below the horizontal plane passing through the source of the light. Here, as will be seen, on the left-hand side is shown the general distribution effected by the holophane globe, while on the right-hand side the distribution that results when only the ordinary glass chimney covers the glowing mantle is employed.

While the holophane glass globes are capable of being made in a great variety of forms, yet they can be conveniently divided into the following three general classes based on the manner in which they distribute the light of the luminous source:—

(1) Holophane globes especially designed for the downward distribution of light. Such globes are suitable for placing near high ceilings, over desks, tables, etc., where it is especially desired to illumine the space directly below the lamp. The general effect of the distribution effected by holophane globes of this type can be seen from an inspection

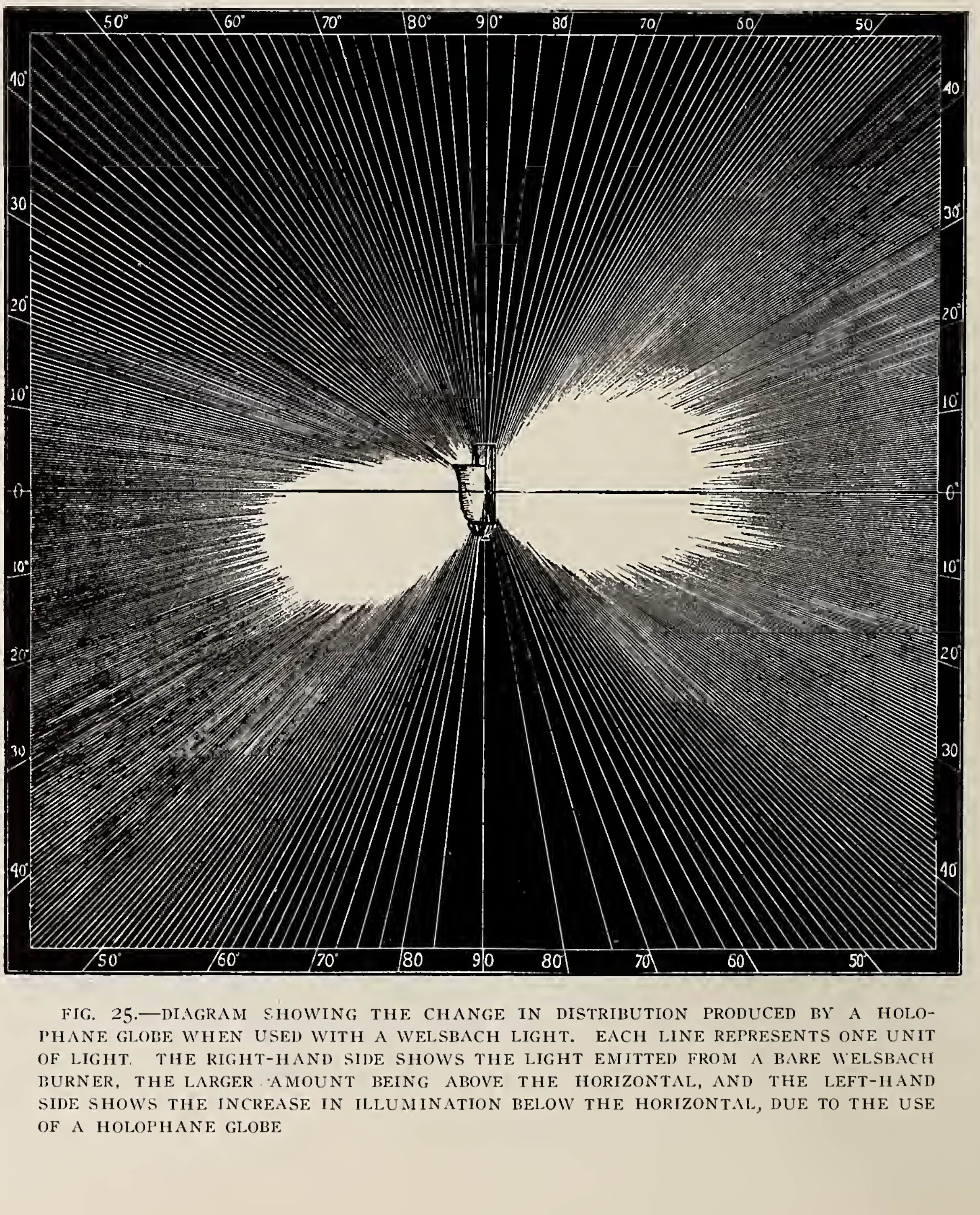


FIG. 25.—DIAGRAM SHOWING THE CHANGE IN DISTRIBUTION PRODUCED BY A HOLOPHANE GLOBE WHEN USED WITH A WELSBACH LIGHT. EACH LINE REPRESENTS ONE UNIT OF LIGHT. THE RIGHT-HAND SIDE SHOWS THE LIGHT EMITTED FROM A BARE WELSBACH BURNER, THE LARGER AMOUNT BEING ABOVE THE HORIZONTAL, AND THE LEFT-HAND SIDE SHOWS THE INCREASE IN ILLUMINATION BELOW THE HORIZONTAL, DUE TO THE USE OF A HOLOPHANE GLOBE

of the photograph reproduced in Fig. 26.

(2) Holophane globes especially designed for the purposes of general distribution of light. These globes throw the light almost equally at all angles below the horizontal. The general distribution that they effect can be seen from an examination of a photograph of such a globe, reproduced in Fig. 27.

(3) Globes that are especially designed for throwing nearly all the light at an angle of from 10 degrees to 20 degrees below the horizontal. Such globes are especially suited for the lighting of streets or large interior areas. The general distribution they effect, together with the photographic image of such a globe, is shown in Fig. 28.

FIG. 26.—GENERAL EFFECT PRODUCED BY DOWNWARD DISTRIBUTING HOLOPHANE GLOBE

FIG. 27.—EFFECT PRODUCED BY HOLOPHANE FOR GENERAL DISTRIBUTION OF LIGHT

FIG. 28.—EFFECT PRODUCED BY HOLOPHANE FOR HORIZONTAL DISTRIBUTION OF LIGHT

The Franklin Institute of the State of Pennsylvania, through its Committee on Sciences and Arts, after a careful examination, awarded to Blondel and Psaroudaki the gold medal of the Institute for their holophane globe in the report from which the following extracts have been taken:—

"The invention submitted for investigation is one that pertains to the diffusion and distribution of light by means of a globe or shade placed around the source of the light.

"The object of the invention is to secure diffusion of the light as well as such a form of distribution that the light, usually lost by being sent off into the space above the horizontal plane passing through the source of the light, shall be distributed in the space below that plane and thus be made useful.

"In order to secure these results, the principles of reflection and refraction are employed, and such a form is given to the contour of the globe as to make these principles available.

"Whenever a beam of light strikes upon the surface of a medium that is not opaque, there are three physical results, namely, reflection, absorption and refraction. In the globe under consideration, reflection and refraction are made use of to secure diffusion and distribution, and as the globe is made of a transparent material, the amount of absorption—which represents a loss—is reduced to a minimum.

"As a result of an examination into the construction of this globe, and an investigation into its practical working, the committee intrusted with this investigation believes that Messrs. Blondel and Psaroudaki have invented a globe that secures much better diffusion and more satisfactory distribution than any other globe known to its members; that the conditions of its manufacture are such that it can be supplied to the trade in commercial quantities; and that the invention has secured a distinct improvement in the diffusion and distribution of artificial light.

"The Franklin Institute, for the reasons above stated, recommends the award of the John Scott Legacy Medal and Premium to Messrs. Blondel and Psaroudaki for their invention."

As will be seen from the preceding illustrations and descriptions, the holophane system unquestionably forms an admirable method of deflecting the light from a luminous source in any desired direction. Moreover, it possesses the advantage of doing this at a comparatively small loss of light absorbed during its passage through the glass globe. In order, however, to insure this comparatively small amount of loss during the use of the globe, it is absolutely necessary that these globes be kept thoroughly clean from dust which readily settles in the deep grooves or spaces between the various flutings on the different surfaces. Where the globes are employed for interior illumination, they can with proper care be kept clean, but where they are employed for street illumination, the dust and dirt, and especially the soot in cities where bituminous coal is employed, collects in the grooves and renders their use almost impracticable for out-of-door lighting. Nevertheless, in some parts of Germany where labour is comparatively cheap, and where incandescent Welsbach mantle lamps are employed for illumination, the holophane globe has been satisfactorily employed on a fairly large scale.

A Thurston Memorial

STUDENTS of Sibley College, Cornell University, Ithaca, N. Y., have ordered designs made for a $1500 bronze tablet which they will erect in memory of the late Dr. R. H. Thurston, formerly director of Sibley. The tablet is being designed by Prof. H. S. Gutsall, of the College of architecture, and will be erected in a stone niche of the new Thurston Hall of Engineering, now in process of construction.

Congress has given permission for telephone and other electric companies of Washington to construct conduits, and the District Commissioners have ordered all wires to be placed underground. Work is to be started at once, with the expectation that it will be completed in about five years. The telegraph companies have been given the privilege of occupying a part of the telephone conduits, a privilege which is to be accepted by the Postal Telegraph Company, while the Western Union Company is to build its own conduits.

It has been arranged by the United States Navy Department that all merchant ships fitted with wireless telegraph apparatus shall make daily wireless reports when they are in touch with the government coastwise stations which will shortly be established in a chain extending from Portland, Me., to New Orleans, and later to Galveston.

The Inspection of Electrical Conductors

With Especial Reference to Fire Protection

By WASHINGTON DEVEREUX

Mr. Devereux, who occupies the responsible position of Electrical Engineer to the Fire Underwriters' Association of Philadelphia, gives, in this lecture, recently delivered before the Electrical Section of the Franklin Institute, a concise statement of the progress and present condition of the art of interior wiring for the protection of buildings against fire from the many sources of danger due to imperfect methods of electric installation.—The Editor.

At an early stage it was found necessary to regulate the manufacture and introduction of electrical equipments. To the British insurance interests may be attributed the credit of compiling the first code, better known as the "Phœnix Fire Office Rules." The rules were somewhat prohibitive, due to cost of installation of apparatus required. In the early days electric lighting apparatus and materials were far more expensive than at present.

The use of electricity for lighting purposes was a rare novelty, and only for the favored few of great wealth. Electricity for power purposes was unknown.

The insurance interests of America were far more lenient and generous than our British cousins. Perhaps we were not so well posted in knowledge of the hazard involved, and were therefore eager to learn and gain knowledge of that mysterious power of electricity.

We have learned much in the past twenty-five years, and yet how little we know after all. In the light and power world "a little knowledge is dangerous indeed," if the individual thus afflicted ventures too far unassisted. As a rule the insurance companies pay for the lack of knowledge.

In the past twenty-five years many fires have originated from defective electric equipment. Many regulations were published by the insurance and electrical interests in an effort to correct previous errors, and while the advancement has been none too rapid in reducing the fire hazard, a marked improvement in the past twenty-five years is most pronounced, and we trust the next decade will enable the engineering world to reduce the hazard of electricity to a minimum.

During the time spoken of, opinions as to the best method of installations varied very much among the insurance and electrical interests, and there was strong desire on the part of both to establish a code which would be acceptable to those most affected. While there is quite a difference of opinion regarding some details, on the whole the present regulations are commendable.

To-day we have the National Electrical Code, which is the result of a gradual development originating with the Phœnix Fire Office Rules, having for its primary object the reduction of the fire hazard from electricity, and secondly, a uniform requirement which could be mutually recognized by the insurance and electrical interests, and a basis for the acceptance or rejection of electrical installations.

We do not claim this to be an ideal code, as experience has shown the necessity for improved equipments. The code is, nevertheless, the expressed opinion of the combined insurance and electrical interests.

A word about the code and its application. To those who are less familiar with the code the following outline will appeal:—

The general plan governing the arrangement of the Rules is as follows:—

Under Class A, Rules 1 to 11 govern the location, arrangement, construction of material, acceptable in central stations; dynamo, motor and storage battery rooms; transformer sub-stations, etc.

Under Class B, Rules 12 and 13 govern outside work, all systems and voltages.

Under Class C, inside work, Rules 14 to 17 govern general requirements, all systems and voltages.

Rules 18 to 20 apply to constant current system.

Rules 21 to 23 consist of general requirements for all voltages, constant potential systems.

Rules 24 to 34 apply to low current potential systems, 550 volts or less.

Rules 35 to 37 apply to high constant potential systems, 550 to 3500.

Rules 38 and 39 apply to extra high constant potential systems, over 3500.

Under Class D, Rules 40 to 63 apply to the details of construction and materials of fittings, etc., all systems and voltages.

Under Class E, Rules 64 to 67 apply to miscellaneous construction, such as signaling systems, electric gas lighting and moving picture machines.

Under Class F, Rules 68 to 83 apply to marine work.

It is almost universal in the United States that installations or equipments should comply with the requirements contained in the National Electrical Code, the latter having been adopted by all local boards of fire underwriters. The development of the code was slow, inasmuch as a piece of apparatus or a class of construction was accepted and regulated before its hazard could be determined. Thus the application of both apparatus and construction has in some cases been confined to narrow limits as the result of experience. The National Electrical Code may thus be said to be the result of broad experience classified.

As we look we are somewhat amazed at the marked difference in the construction and installation of apparatus. During this period certain features seemed to mark a new era in this particular line, yet in but a short time another feature of equal import was introduced. The history of the National Electrical Code is made up of a series of discoveries.

At an earlier date the importance of wire insulation was not recognized, and bare copper conductors, with a difference of potential from 300 to 500 volts, were stapled to woodwork, and this method of construction was considered good practice. Difficulties were encountered, as must be expected, such as electrolytic action, grounds, short circuits and fires, and these were only limited, due to the fact that very few plants were in operation. It was learned that these difficulties could be reduced to some extent by covering the conductors with insulating material. Paraffined cotton was used, the insulated conductors being held in

place by means of wooden cleats. Such an insulation is highly inflammable, and while some difficulties were eliminated, the fire hazard was greatly increased. This led to the adoption of the "Underwriters" wire. The insulation on this wire consisted of cotton and asbestos fibre, impregnated with white lead, and was fire-proof (and was and is to-day most serviceable in hot drying rooms, boiler houses and places of like nature), but not damp-proof, reducing to some extent the fire hazard, but presenting the serious objection in that it was materially affected by dampness and had a very low insulation resistance compared with that of cotton paraffined wire.

The wiring contractors make formal application for inspection to the underwriters having jurisdiction. The examinations are made by trained inspectors, whose duties require a strict compliance with the requirements. In the examination, points not covered by the code are pointed out and corrected. This inspection tends to educate those directly or indirectly connected with electrical matters by this transference or interchange of ideas. New ideas are reserved for future consideration by the National Board of Fire Underwriters, and after acceptance are made a part of the revised code. Thus the latter is a flexible requirement, changing with the changing of ideas or customs, adjusted to suit these new ideas and customs, but always improving.

In addition to the use of wood cleats for mechanical support, the conductors were laid in V-shaped grooves in wood joist, unprotected except by the wire insulation. The conductors were subject to mechanical injury and breakage, as the floor boards were sometimes unevenly laid, very often loose, and a constant wear was sustained by the conductors, as the occupants of a building would tread upon the surface wired over. Occasionally joists were bored and the conductors drawn through wooden base switches, and open-link wooden cut-outs served as controlling and safety devices in all cases on low potential system, 110 to 220 volts.

The weakness of the above methods was soon noticed and eliminated to this extent: the conductors were no longer laid in V-shaped grooves, and the holes in joists through which conductors passed were bushed with soft rubber tubing. This insulation proved a failure. Then followed the hard rubber tube; failure again resulted. Papier maché tube treated with several coats of asphaltum was next used, then papier maché sheathed with brass. All in turn were failures, lacking qualities desired, and necessary solder was at a premium, judging from the number of unsoldered joints. Tin foil was often used as a substitute, principally with a view of deceiving the inspector.

The necessity for support of higher insulating qualities developed the porcelain knob and cleat. The application of glass and porcelain to the manufacture of insulators and of porcelain to the manufacture of cut-outs and switch bases was a marked stride in the development of higher quality of electrical fittings. The "Underwriters," or composition asbestos wire, had in it the weak feature that it was readily affected by moisture. This wire was later covered with a cotton or hemp braiding coated with asphaltum, pitch and tar, or a composition similar to Chatterdon compound, making a comparatively good insulation. While fresh this insulation will burn readily, but when thoroughly dried out is of slower combustion, and is commercially known as "Slow-Burning," sometimes "Fire and Weather-proof." The latter title, however, is erroneous and misleading.

The necessity for an insulation having a higher value than "Underwriters" and "Slow-Burning" insulations was apparent and lead to the construction of rubber-covered wire. This was followed with a rubber-covered wire having a single outer wrapping of tape. Two weaknesses were noted—first, the copper wire was chemically affected by the sulphur mixed in with the rubber, and, second, the outer covering dried up, unwrapping or otherwise exposing the inner insulation to a varying atmosphere, eventually drying and cracking the rubber. The first trouble was remedied by tinning the wire, the second by applying a braid of one, two or three layers. From the number of layers of braid we name the wire; for instance, the triple braid having in addition to the rubber insulation three distinct braids of insulating material. Undoubtedly the braid greatly enhanced the insulating value of rubber-covered wire.

We have briefly scanned the field, from the use of bare wire stapled to the rubber-covered wires, mechanically supported by knobs and tubes. This is indeed a great improvement, and it will no doubt surprise you to note a backward step. Knob construction was found objectionable from an artistic standpoint, also because the wiring in many instances was subject to mechanical injury. The circuits thus disarranged, coming in contact with gas pipes, water and steam pipes, caused grounds, leaks in multiple, and many times created a fire of more or less magnitude. Thus the need for some device that would entirely conceal the wire, brought forward the "Astrakan" moulding. This moulding was made of hard wood, grooved in the back. The wires were laid in the grooves and nailed anywhere. This class of construction was not without fault, and its adoption was indeed a backward step. The rubber wire, very often resting against new plastered walls and ceilings, was acted upon by the chemical limes, etc., rapidly deteriorating the insulation and creating a fire.

The "Astrakan" moulding was soon replaced with the present two-piece moulding, though of lighter construction and untreated with a moisture-repellant, and the same disastrous results followed, as in the adoption of the "Astrakan" moulding, to a lesser degree, however. The present moulding is of heavier construction, thoroughly treated with two and sometimes three coats of moisture-proof paint, and has proven fairly satisfactory. Care, however, is needful in installing moulding work to avoid wet places or where the possible overflow of a tank, sink or accidental breaking of water pipe may saturate the moulding and thus cause a fire.

Attention was given to the development of some form of insulation between gas fixtures and the house piping. An insulating joint having soft rubber insulation was adopted, but failed owing to the chemical changes in the rubber and its mechanical weakness. The principal weakness, however, was the extreme inflammability of the rubber. "Bug" cut-outs were invariably placed in the canopies of fixtures. The melting of a fuse many times would flash sufficiently to ignite the soft rubber, which quickly communicated with the illuminating gas contained in the house piping, creating a fire close to the ceiling. Sometimes side brackets, located on hollow frame partitions, were thus affected. The fires were not easily controlled, as it was always necessary to turn the gas supply off at the meter. Before this could be accomplished a fire of no small proportion sometimes occurred.

The soft rubber joint, after a few years proving unsatisfactory and unsafe, was replaced by the hard fibre joint, and finally the mica insulating joint, which, while not indestructible when subjected to an electric arc, has proved more satisfactory than any insulating joint yet produced. Its introduction greatly reduced one of the most serious weaknesses in an electrical installation.

If we will but consider that the combination gas and electric fixture

contained two factors having dangerous characteristics if improperly handled, being readily able to puncture the gas pipe and ignite the gas by the consequent spark (arc), we more readily appreciate the real value of the insulating joint. The possibility of grounds to earth on fixtures attached to gas piping has been reduced by the use of the mica insulating joint. It was also required to cover the wires at the outlet to avoid possible contact with the house piping. This was accomplished by covering the wires with soft rubber tubing, a poor remedy. Later the improved means of flexible, slow-burning tubing was used, and finally porcelain tubes.

"It is also recommended that the gas outlet pipe be protected above the insulating joint by approved insulating tubing, having a flange at the lower end where it comes in contact with the insulating joint." The use of electric gas lighting on the same fixture with electric lighting is most inadvisable, as the insulating joint is rendered practically worthless by the gas lighting wires bridging it. In fact, straight gas or straight electric is the best practice.

Probably no portion of the electrical equipment, with one exception, is more roughly handled than the sockets, and the introduction of the lined socket was a marked improvement indeed.

The great need of a wireway or raceway for electrical conductors was most apparent—a method, if you please, whereby the electrical conductors could be more systematically installed and at the same time practically accessible at all times. The desire to better general conditions brought forth the "interior conduit system," which consisted of tubes of papier maché, treated with several coats of asphaltum, an excellent insulating composition, but very inflammable, Iron outlet and junction boxes, into which the tubing and open-link cutouts fitted nicely, completed the system which was pronounced by many as ideal. The owners of these patents and stockholders reaped large financial gains.

The serious objection to this system was its liability to mechanical injury and its inflammable qualities. The applying of an outer thin brass covering, forming what is known as brass armored tubing, did not remedy the difficulty, as the brass was readily punctured, adding an additional defect in the form of a sharp projection, very often cutting the insulation and increasing the fire hazard.

The great problem is how to secure safety, and this may be solved by the proper method of construction, using only high-grade material. The fire hazard should be always carefully considered in an electrical installation, and the National Electrical Code carefully applied. In applying the code care must be taken in the proper discrimination of the hazard and to apply that electrical system which will be less apt to increase the hazard. The equipment should be installed by skilled wiremen, guided by experienced engineers. Evidences of the lack of knowledge on electrical subjects are quite apparent—nails and screws driven into electric light and power moulding, wires in contact with gas pipes, water pipes, water tanks, metal awnings, metal ceilings, iron beams, cornices, awning frames and metal signs. The introduction of various auxiliary devices for varying the candle-power of lamps, lamps in series with bell and telephone systems and connected to lighting systems, and other similar makeshifts are in the wrong direction, increasing the fire hazard, not necessarily because of faulty construction, but because their constant manipulation is in the hands of those less informed or absolutely ignorant of the danger involved.

In the manufacture and distribution of electrical energy there is a loss by heating due to the fact that all substances have a resistance which has to be overcome and which represents a loss in energy, which is substantially all transformed into heat. The heat which is produced in a wire only depends on the number of watts expended electrically by the current in overcoming the resistance of the wire, which resistance varies with different materials, and raises the temperature of the conductor and indirectly that of the surrounding bodies; and this rise continues until the rate at which heat is lost equals that at which it is generated; then the temperature becomes constant. It is obvious, therefore, that an electrical conductor is only capable of carrying a certain current with a given elevation of temperature, and practically the allowable temperature is limited by consideration of injury to insulation and the danger of fire.

The lined iron conduit was next introduced. The conduit was of iron, having the general characteristics of gas pipe as to size and quality and was bushed throughout its entire length with a treated wood or papier maché lining. This class of tubing presents numerous objections. The most serious is perhaps its liability to fracture the insulation of conductors during the process of "drawing in," the wood lining often giving way, forming sharp projections and puncturing the conductors. This tube was soon followed by a galvanized iron pipe, similar to gas pipe, but galvanized to prevent corrosion. The iron conduit is an inflexible system, and the demand for a system of piping having all the properties of iron conduit with additional flexibility, led to the "flexible iron" conduit system.

The outline here given of the improvements in methods of construction is only of the more important. The step from uninsulated wire stapled to double-braided rubber-covered wire in metal conduit is a big one, covering more than twenty-four years of slow and steady care in selection.

The insurance inspector has played no small part in these improvements. His experience with the various classes of apparatus or of construction has sifted out the bad features, and only the most improved appliances and fittings withstand his criticism. Years of experience, of tug and tussle, of acceptance and rejection, have resulted in the present National Electric Code.

The temperature elevation of a wire for a given current strength depends upon its resistance, diameter, covering and its surroundings. A copper wire carefully insulated by a thin coating of water-proof material and placed in still water is usually kept comparatively cool, owing to the rapid conduction of heat through the insulated cover into the water. The same wire, carrying the same current, but suspended in air instead of being immersed in water, will usually attain a considerably higher temperature, as still air does not carry away heat from the surface of the wire so effectively as still water. For the same reason a wire buried in the ground will, in almost all cases, be found to be cooler than where supported in the air. A covering of, say, cotton, rubber, or other electrical non-conductor will, up to a certain thickness, serve to cool the wire by increasing its surface.

The same heating conditions would apply to switches, switch or fuse lugs, bus-bars, commutators, and in fact to any current-carrying parts of a circuit, and it is therefore necessary that they be sufficiently heavy to carry the required current without undue heating. Heating may be the result of insufficient contact surface, and the tendency in all cases is to increase the temperature to a dangerous point, or to melt and ignite the insulation of an inflammable nature, such as rubber and cotton. It is necessary, therefore, that the carrying capacity of current-carrying parts and of contacts shall be limited.

Poor connections at fuse blocks may produce heat enough to cause the fuse to melt when there is really no trouble

elsewhere on the circuit. This may occur when the fuse blocks have too little contact surface at the connection points to properly carry the current, or when the contact surface is not secure, in which case arcing occurs, pitting the surfaces and intensifying poor contact.

The formation of an arc may be understood by the following explanation:—The two conducting terminals under ordinary circumstances are brought together before being separated to establish the arc. As soon as this separation commences, the spark which tends to form at any break in a closed circuit vaporizes a portion of the materials of the electrodes, thus establishing a bridge of conducting vapor through which the current flow is maintained. The concentration of energy in a small space produces an intense heat, which vaporizes the electrodes more rapidly. The temperature of this arc, although difficult to determine accurately, is about 3500 degrees C. We may obtain an approximate idea of this heat when we consider that about 500 degrees C. are necessary to make solid bodies glow with light, and that the melting point of platinum is 1775 degrees C.

As was noted previously, the presence of two leaks on an electrical circuit, creating an electrolytic action and finally a break in a circuit, is attended with the destructive arc. It is equally true that the breaking of any circuit, whether it be by means of a properly proportioned switch, the melting of a fuse, or the breaking of a current-carrying wire, is attended with this arc. Where the numerous blowings of fuses have occurred, the porcelain surface of the fuse block is often covered with a layer of metallic substance, which becomes a partial conductor. Upon the repetition of this blowing, an arc is formed and maintained by this metallic layer; in many cases the porcelain cover is fused and broken.

In other cases, particularly with slate switch and distributing boards, the melting and resulting arcing have been known to crack the insulating substance and short-circuit the various conductors. In other cases the short-circuiting of an incandescent lamp has destroyed the sockets or controlling devices beyond repair. The throwing out of sparks from arc lamps and the dropping of hot carbons have been known to cause fire. Sparks from the commutator of motors, from the short-circuiting of flexible cords and of fixture wires, from the short-circuiting of cables in conduits and in man-holes, igniting accumulated gases, from short-circuits in sockets, attachment plugs, receptacles, switches and various other devices have been known to cause fire.

Overheating of wires, of motors, dynamos and switchboards from overloads, overheating of starting boxes, overheating of theatre dimmers and regulating boxes from overload, overheating of improperly made joints, which may be considered the weakest part of an installation, and may include joints between wires, between wires and lugs, between lugs and bus-bars, or between switch blades and clips, overheating of magnet coils or resistance of arc lamps, and innumerable other similar defects have been known to create a fire.

Other sources of fire may be the contact of an incandescent lamp with inflammable material, such as cotton, paper, wood, celluloid goods, etc.; still others are the melting of fuses, the breaking down of insulation, sparking from electrolysis, or shirt-circuits in places impregnated with inflammable gases, such as benzine, naphtha, ether, hydrogen, gasoline and many others of explosive nature; also in any class of manufacture where vegetable material is distributed through the atmosphere in the form of dust extra precautions are absolutely necessary, the least flash or arc being sufficient to cause an explosion.

Candy factories, sugar refineries, flour mills, breweries, saw mills and others of like hazardous nature may be considered in this category, also textile mills, where there is an accumulation of the particles of stock that are carded out, which particles, owing to their extreme lightness, fill the air in the rooms, and, settling, completely cover everything with an inflammable material usually known as "fly," which is a fine dust of vegetable matter. In this condition the dust may be ignited by the blowing of a fuse or similar accident.

It will be noted from the remarks made in this paper that electricity is treated as a source of heat and as such is classed as a fire hazard, and it is fair to say that it presents to us a most dangerous and powerful factor in that respect, if an equipment is improperly installed, abused, or permitted to be neglected. That electrical equipments are abused and neglected is a fact too well established to permit of argument. This is particularly true of isolated plants. There is no class of industry which should receive greater consideration than the interior wiring of buildings for light and power purposes.

A word to the public:—Engage only reputable electrical contractors and engineers, who in turn may be presumed to employ artisans skilled in their calling; and, as a further precaution, do not pay a bill for additions, alterations or repairs to any portion of an electrical equipment until a certificate of approval has been furnished by the Board of Fire Underwriters having jurisdiction, or other properly constituted authorities.

In referring to the fire hazard of electricity, we must not lose sight of the fact of the great benefits which this subtle force has bestowed upon mankind. Electricity will cause fire under certain conditions; the same agent, regardless of the cause of fire, is used in sending out the fire alarm, affording quick and ready relief. This may be accomplished by the police and fire alarm systems, else the automatic alarm, a silent monitor and a watchman, who never sleeps. By the same power the electric fire pump automatically supplies water in abundance to the fire mains, stand pipes and automatic sprinkler systems, thus rendering great assistance to the fire department in the execution of their duty.

By the aid of electricity we can send by telephone or telegraph messages to all civilized parts of the earth. Civilization is crude indeed if electricity has not made its impress upon the surroundings. Humanity has greatly benefited by the use of the Finsen light and the X-Ray. Electro-therapeutics to-day is indispensable to the medical and surgical world. In fact to enumerate the innumerable great and lasting benefits which electricity has afforded humanity is a task beyond the ability of any man.

After due consideration of the fire hazard involved, we must admit, if properly installed and not abused, electricity is the safest source of light which the ingenuity of man has produced, and its fire record is far below the oil record, and its casualties are nil when compared with oil lamp statistics.

A recently described electric hair-cutting machine consists of a comb over which is stretched a platinum wire placed in circuit with a source of current by screwing a plug connected to the machine into an electric light socket. Upon closing a switch in the handle of the comb the wire is brought to a bright heat, and as the comb is drawn through the hair the wire burns off the ends, singeing the hair at the same operation. Since the hot wire is not a live flame, the hair cannot be set on fire, as with the ordinary singeing apparatus.

The telephone is to take the place of the telegraph on the Castel Raimondo-Camerino Railway in Italy. This is the first change of its kind in that country.

Some Recently Improved Forms of Electric Lamps

By F. C. CALDWELL

A Paper Read at a Recent Meeting of the Ohio Society of Mechanical and Electrical Engineers

WE sometimes hear the idea expressed that the golden days for the electrical inventor are passed, that electrical apparatus has been so perfected during the last 20 years that there remains but little for the coming engineer to do but to operate it. When, however, we realize that less than one-half of 1 per cent. of the energy put into our boilers in the form of coal is available to the customer who buys electricity for light, it seems that still there is something left to do.

It is quite certain that there will be no disagreement upon the proposition that the 10 to 15 per cent. efficiency of the steam engine is very unsatisfactory to the mechanical engineer. The electrical engineer will be likely to point to the high efficiency of dynamo machinery and to urge the mechanical engineer to try to emulate the perfection reached therein. But the latter may well retaliate by calling the attention of the electrical engineer to the efficiency of from 2 to 5 per cent. obtained in apparatus for converting electrical energy into light.

There are two ways in which improvements in efficiency may be hoped for. One is yet an unworked field, where only the firefly and the various phenomena of phosphorescence point the way. The firefly has a light efficiency of practically 100 per cent., and it is well within the range of possibility that we may yet see the transmission of light-producing energy entirely done away with and a return made to some form of portable lamp, in which an exceedingly small amount of material is consumed. We should then have what, in the case of the firefly and phosphorescence, is called a "cold light"—that is, a moderately illuminated but large surface, in which so little heat is produced that it cannot be detected by the hand.

For the present, however, interest is chiefly centered in the second method of improvement in the efficiency of sources of light, and the lamps which will be here considered are chiefly developments along this line. When light is sent through a prism it is decomposed into a band of colours beginning with violet and shading gradually into red at the other end of the spectrum, and each of these gradations of colour represents a particular wave length of light. The violet is the shortest, having a length of 0.0004 millimeters, or about 16 millionths of an inch, while the longest red ray is not quite twice as long. While these are the only wave lengths that are visible to the eye, every incandescent object also gives off heat rays of longer wave length, and these longer waves are always present in a heated body, whether it is hot enough to glow or not. The efficiency of any light, measured as we measure the efficiency of a boiler or engine, is the ratio of energy given off in light-giving rays to the total energy received, which approximately is equal to the total radiated energy, and this ratio is very small.

Recent tests show that in the case of the incandescent lamp worked at normal voltage, it is only about 2.6 per cent. As the temperature of the body is increased, a larger part of the radiation comes within the light-giving range, and consequently the efficiency becomes higher and higher and at the same time the light becomes whiter. There is, of course, no limitation to the temperature that can be obtained by means of the electric current, provided sufficiently refractory materials can be provided to sustain extremely high temperatures without disintegration, and to obtain such materials is one of the great problems for the student of methods of lighting.

Thus far, I have spoken as if the only consideration were high efficiency. A striking illustration of the falsity of such a position is offered in the direct-current, open-arc lamp. This lamp has been rivaled in point of efficiency by only one other luminant, namely, the mercury vapour lamp. It was, moreover, the first electric lamp to be introduced into commercial service. However, in spite of its high efficiency, it is being rapidly replaced by less efficient, but more satisfactory, forms of lamps and looks as if it were fated to become a museum curiosity within a very few years.

Before going farther, a brief review of the essential characteristics, other than high efficiency, which are necessary for a first-class source of light, will be profitable. In the first place, the colour of the light must be satisfactory for the purpose for which it is to be used. Thus, if for general illumination where appearances count, or for working with colours, the light should be as nearly white as possible, but if only required for the distinction of black lines on white paper, a light of another colour may do as well or even better.

The second important qualification is steadiness, and a proper distribution is also desirable. Again, from an economic standpoint, the lamp must not require too frequent attention, and if it can be supplied in small units, it will have a great advantage for many purposes.

It will be convenient at this point to divide lamps into two classes,—arc and incandescent. As the former were the first to appear upon the stage of electric lighting, we will consider them first. As previously stated, in its original form, the direct-current, open arc has been very largely displaced by the enclosed arc. The reason for this change has been the much greater steadiness of the light and a much lower cost of attendance, as well as a better distribution. In the case of the latter lamps it will not be necessary to discuss the method of operation, but it may be of interest to call attention to the fact that the enclosed lamp has made possible the application of alternating currents to arc lighting.

Open arcs have not worked satisfactorily upon alternating-current circuits, and in spite of the fact that the enclosed lamps have a much lower maximum candle-power for the same amount of energy consumed, they have nearly or quite as much candle-power when viewed from a little below the horizontal, and, therefore, are even better suited for street lighting. In this case the minimum illumination midway between the lamps is the point to be considered, while the bright light given by the open arc just below the lamp is a positive disadvantage on account of the blinding effect. This is especially true when a person is passing rapidly along the street.

Recent efforts toward the improvement of arc lamps have been in the direction of combining the high efficiency of the open arc with the long life, steadiness and superior distribution of the enclosed. In all of the arc lamps now in general use the light comes entirely from the carbons, which are heated to a very high temperature, the arc itself being practically non-luminous. The endeavour of workers in this field at present is to obtain an arc which shall itself be luminous, and two methods have been tried to accomplish this.

It has been found that by impregnating the carbons with certain chemicals, a luminous arc and a considerably higher efficiency can be obtained. It has not, however, been found practicable to apply this method in the case of enclosed lamps on account of the heavy deposit on the surface of the globe. The lamps, therefore, suffer from the disadvantage of the short life of the carbons, just as do the other forms of open carbon arcs. The other method of obtaining luminous arcs is to substitute for the carbon some entirely different substance which will fulfil the requirements of the high-efficiency long-burning arc.

This has been accomplished with seemingly great success by C. P. Steinmetz of the General Electric Company. His lamp is known as the "magnetite" arc lamp and uses for the stick or pencil which is consumed a combination of an iron ore, known as magnetite, with certain other chemicals, notably titanium oxide. This material is made into an exceedingly fine powder and packed in a very thin iron tube 8 inches long and ½ or ⅝-inch in diameter, and is used in place of the lower carbon. In place of the upper carbon is a piece of copper, which forms a part of the lamp and is not consumed. By properly proportioning the material of the lower or negative pencil, a very steady luminous arc, about ⅞-inch in length, is formed. It has a considerably higher efficiency than the enclosed arc lamp and is said to possess an average life of 100 hours for the ½-inch, and 180 hours for the ⅝-inch. It is said that these carbons will be sold for about $50 per thousand.

No inner globes are used with these lamps, and on account of the formation of a fine dust or smoke in considerable quantities, they are not suitable for interior illumination, except in mills or similar buildings where such smoke would not be objectionable. It is also necessary to have a small chimney through the centre of the lamp to carry away this dust, thus preventing it from lodging upon the outer globe and interfering with the passage of light. The absence of an inner globe, together with the expense due to breakage and cleaning, is considered one of the greatest advantages.

In this lamp practically all of the light comes from the arc itself, neither of the electrodes being heated enough to give any appreciable illumination. It is for this reason, together with the non-combustible character of the iron oxide of the negative electrode, that the life of the latter is so long. These lamps burn preferably with about 3½ to 4 amperes and 80 volts, and are run in series by direct-current, arc-lighting machines, such as were used for the old-fashioned open arcs.

Describing a 6 months' experience with these lamps, W. E. Holmes has stated in a paper before the National Electric Light Association, that when compared with 460-watt enclosed lamps, both alternating and direct current, the illumination given by the magnetite lamp at a distance is considerably better than that furnished by the 460-watt enclosed lamp. Since there is no heated carbon surface from which the light has come, the maximum candle-power given by this lamp is in a horizontal direction, thus particularly adapting it to the illumination of streets and similar places where light is required at a distance from the lamp.

In the case of the incandescent lamp, there has been a great improvement in the efficiency and life of the carbon filament lamp since its earliest days. A limit, however, seems to have been reached and there is little hope of obtaining either higher efficiency or longer life than is now available. It has, therefore, become necessary to search for a more refractory material than carbon.

The first commercial success in this direction was achieved by the Nernst lamp. It was discovered by Mr. Nernst that if a small piece of material of about the character of porcelain were heated to a red heat it ceases to be an insulator and becomes a fairly good conductor of electricity; also that its resistance decreases very rapidly with further increase of temperature. On account of its highly refractory character it can be run at a high temperature, thus giving a very high light efficiency without rapid deterioration, even when exposed to the air. There were, however, two serious difficulties to be overcome before it could be made of practical use. In the first place, it was necessary to provide some means of bringing the material up to a red heat before it would take the current.

This at first resulted in the production of a somewhat incongruous affair; namely, an electric lamp which had to be lit with a match. Naturally enough, this was not considered up to date, and the inventors proceeded to develop means whereby the filament could be heated by a fine platinum wire wound upon a cylinder and placed near it, which would take the current when first turned on, but which would be cut out as soon as the Nernst filament was brought up to the proper temperature to carry the current.

Another difficulty was the fact that the resistance decreased rapidly when the temperature increased. With this characteristic, if the filament were placed directly in an approximately constant potential circuit, and then the voltage should be slightly increased, the resistance of the filament would decrease sufficiently to allow the passage of enough current to destroy it. This difficulty also was overcome by means of a so-called "ballast"—that is, a piece of very fine iron wire inclosed in a tube containing a gas which would not oxidize it. This was placed in series with the filament and normally run at a low red heat. The resistance of iron at this stage increases rapidly with increasing temperature, and more than makes up for the decrease of resistance of the glowing filament.

Filaments for Nernst lamps are made in two sizes, one taking about 0.2 ampere at 220 volts, giving 25 candle-power; the other taking 0.4 ampere and giving 50 candle-power. This corresponds to about 1.6 watts per candle-power, and about double the efficiency of the carbon filament lamp. Furthermore, on account of the high temperature, the character of the light is very superior. The construction of the lamp is such as to throw the light strongly downward, which is an advantage, especially in rooms having dark walls. These lamps are also made with two, three or six of these filaments combined, thus giving 100, 150, or 300 candle-power. The latter are suitable for replacing arc lamps, while the 50-candle-power size will give good satisfaction when replacing a three-light incandescent cluster. The figures previously given are for alternating-current lamps.

Nernst lamps are also made for 110-volt circuits and for direct-current circuits, but with these the life of the lamp is not nearly as long and they also take more power. A part of the saving in current made by these lamps must be expended for additional maintenance, for in order to get satisfaction from them it is necessary that they be inspected at fairly frequent intervals and that the globes be thoroughly cleaned when the burnt-out glowers are replaced.

The next lamp to make its appearance as a factor in commercial lighting was the Cooper Hewitt mercury vapour lamp. Here the source of light, instead of being an incandescent solid, as is the case in other incandescent lamps, is a glowing gas, viz., mercury vapour. The action of a gas when heated to incandescence is quite different from that of a solid. We no longer have a gradual change from red to white as the temperature rises, but the light appears with the characteristic colour, which simply becomes intensified as the current increases. This class of lamps also has a very high efficiency, the mercury vapour lamp taking only about 0.4 watt per candle-power, thus making it more than twice as efficient as the carbon arc lamp, and nearly ten times as efficient as the carbon incandescent. This form of lamp will operate only with direct current. It is built commercially in sizes ranging from 180 to 700 candle-power, and for voltages from 50 to 150. Its most serious drawback for many purposes is the colour of its light, which is almost purely green. This takes all appearance of red out of whatever surfaces it falls upon, and gives a ghastly appearance to both objects and persons.

Wherever colour values are of importance and any regard is necessary for the good appearance of things, the mercury lamp is entirely unsuitable. On the other hand, in drafting rooms, shops, etc., it is claimed that the lamp can be used with much less strain upon the eyes of workmen than is experienced with other forms of illumination, and in such cases its very high efficiency is a strong recommendation. It has also proved most useful for photographic purposes. In the new "Times" building in New York are forty-two of these lamps, distributed through the press rooms and other work rooms. This lamp, when in the place to which it is adapted, has unquestionably come to stay.

The latest comer in the incandescent lamp field is a lamp developed by the Siemens & Halske Company, of Berlin. This lamp makes use of a filament of the metal tantalum heretofore but little known, but which seems to be most promising. Like other metals, its resistance increases with increase of temperature, and therefore it is not as sensitive as the carbon filament to variations in voltage. As now placed on the market it requires about 1.7 watts per candle-power, and the average life is about the same as that of the carbon filament.

According to recent statements, there is very little blackening of the bulb, which is such a serious factor in decreasing the light given by carbon incandescents. From the foregoing figures, it appears that the efficiency is approximately double that of the carbon lamp. On account of the comparatively low resistance of the material, the filament has to be made about 25 inches long, and to support this within an incandescent lamp globe of the usual size was quite a problem. It has been solved by the use of two star-shaped supports, separated about 1¼ inches, between the points of which the tantalum wire is wound. This lamp is already being manufactured and sold at the rate of about 5000 a day. It is sold wholly on its merits, without advertising, and so far it cannot be obtained in quantities in this country, the product being entirely consumed abroad. This lamp is made for 110 volts, in candle-powers as low as 22.

Brief mention may also be made of two forms of lamp which are at present in a state of development, but which may in time become important factors. In these are used the rare metals zirconium and osmium. Both of these lamps are claimed to have efficiencies about double that of the incandescent lamp, and it is now stated that the osmium lamp has been made for 110 volts, although there has been difficulty in perfecting it for voltages as high as this. It is also claimed that the osmium lamp has very long life, averaging considerably over 2000 hours, which is exceptionally long when compared to 800 hours for the carbon lamp.

The lamps which have been described may or may not be the eventual successors to the carbon lamp, but there seems little doubt that some form of incandescent lamp will be developed which, while being comparatively inexpensive, will reduce the cost of current to about one-half of what it is at present. With this improvement, together with the lower price at which current is destined to be sold, we may well look forward to a much more universal adoption of electric light than is possible at present.

Elgin, Ill., has decided to lease its municipal lighting plant, and La Grange, in the same State, has sold its plant outright. In both cases the plant was being operated at a loss.

German capitalists have formed a company for operating electric cabs in Buenos Ayres, in Brazil.

The American Street Railway Association

PHILADELPHIA MEETING, SEPT. 25-30

THE twenty-fourth annual meeting of the American Street Railway Association will be held in the South Building, Philadelphia Museum, Thirty-fourth street, Philadelphia, Pa., September 25 to 30, 1905. The Mechanical and Electrical Association and the Claim Agents Association will meet Monday and Tuesday, 25 and 26; American Street Railway Association, Wednesday and Thursday, 27 and 28; Accountants' Association, Thursday, Friday and Saturday, 28, 29 and 30.

The report of the reorganization committee will be presented and acted upon, a new constitution and by-laws have been prepared, and it is the desire of the executive committee that as many of the members as possible be present to consider them. Papers will be presented on gas and other engines, organization, and the single-phase system for street railways. The Manufacturers' Association expect to have the largest and best exhibition of appliances ever shown at any convention. As this will be their first exhibition, they will make it a great success. The hall has over 60,000 square feet of space.

The passenger associations have granted rates of fare and one-third on the certificate plan.

The headquarters will be at the Bellevue-Stratford Hotel. Rates are as follows: European plan—single rooms, without bath, $2.50 per day and up. Single rooms, with bath, $3.00 per day and up. If two persons occupy a single room, the rate will be $1.00 more. Double rooms, without bath, two persons, $3.50 per day and up. Double rooms, with bath, two persons, $4.50 per day and up.

In the latest and most economical way of gathering rubber in New Guinea the natives tap the rubber trees and smear the gum in layers over their bodies. The heat of their bodies and the sun dry the solution up, when "they march off like mechanical rubber dolls to the dealers, where they are stripped and released, to gather more of the valuable gum." An india-rubber credulity is suggested as a necessity in reading this item of news.

Electrically-lighted signs and other electric illumination have combined to make Broadway, New York's main thoroughfare, the brightest street in the world at night.

Automatic Synchronizing of Generators and Rotaries

By PAUL MAC GAHAN, of the Westinghouse Electric & Manufacturing Company

A Paper Read at the Recent Convention of the National Electric Light Association, at Denver, Col.

THE tendency in central-station development is to eliminate as much as possible the personal element in operation, to introduce labour-saving devices, reducing the cost of operation, and automatic apparatus of every description to minimize the amount of attendance required, so as to prevent errors and accidents, and to insure continuous operation.

The synchronizing of generators or rotaries has been the stumbling block in most installations; for a good many years the incandescent lamp method was the only one successfully employed to indicate when the machines were ready to couple. If the lamps were connected across the main switch to similar phases, the voltage across their terminals would be a minimum when the machines were in phase, and a maximum when in opposition, thus indicating by their dark period the proper instant for throwing the switch in, and by their flickering or pulsation the amount the incoming machine differed in frequency from the bus-bars. When the lamps were cross connected, they would indicate the proper instant when at their maximum brilliancy. Much was left to the judgment of the operator, for the lamp did not indicate whether the incoming machine was too fast or too slow; the illumination was a function of the voltage as well as the phase, and, moreover, the darkness of the lamps embraced a very large angle of phase difference. It was necessary to estimate half the time of the dark period, and this was difficult to do, as incandescent lamps have a period of their own, requiring an appreciable time to heat up and cool off. Many will remember the time and the careful, patient manipulation required to synchronize by means of lamps.

The first improvement in methods of synchronizing was the introduction of the "synchroscope," an instrument that rotated a pointer in synchronism with the difference in speeds of the machines. This instrument has the widest general application to-day, for it gives perfect indications of the phase relation between the machines at any instant, and shows whether the machine coming in is too slow or too fast. It does not, however, make an allowance for the time required to close the coupling switch.

The electrically-operated switches generally used for high-tension work, and sometimes even for low-tension work, require a certain definite time to close after the closing current is established. This time varies for different kinds of switches, and the operator has to make an allowance for it in synchronizing, and must close the tripping contact in advance of the actual instant of coincidence of phase, to connect the machines in a safe and satisfactory manner. Moreover, he has to take into consideration the speed at which the synchroscope pointer is approaching the zero point, and make a greater angular allowance on the dial, when the speed is greater. He has to judge what difference in speed gives a safe coupling, and, as a usual rule, will wait until he gets the pointer practically stationary before throwing the switch in. Given a variable speed, or sudden surges in the power in addition to the above variable elements, the operator has to contend with a combination of circumstances which prevents the synchronization being made quickly and which requires a man of judgment to control properly.

Thus it will be seen that if a device could be designed that would automatically respond to the above variables, and close the circuit at the proper instant in a safe and positive manner, the skilled operator could be dispensed with, and the coupling could be done in much less time.

A successful automatic synchronizer should fulfil the following conditions:—

1. It should be certain and safe in its operation.

2. It should take advantage of the first favourable opportunity for coupling.

3. It should couple the machines as soon as the difference in speeds is reduced to a safe amount.

4. It should close the contact in advance of the period of coincidence a sufficient amount for the switch to act, thus coupling the machines at the exact point of synchronism. The greater the difference in speed, the greater should be this advance in angle, in order to make the time allowed constant. As different kinds of switches require different lengths of time to close, the amount of advance should be adjustable.

5. It should prevent the coupling taking place if the speed of the incoming machine differs too much.

6. If anything in the mechanism fails, it should prevent the coupling.

7. It should not close the contact when the machines differ seriously in their voltage, even though in phase. Although a fairly wide difference in voltage is permissible in synchronizing, and will not cause as great a rush of current as a wide difference in phase or speed, it should be nevertheless guarded against. A difference in voltage of 25 per cent. may cause a serious interchange of current between the machines; a difference of phase of 15 degrees will generally cause more. There have been many attempts in the past to devise a satisfactory automatic synchronizer, but none of them heretofore has been successful, as the apparatus did not fulfil all of the above conditions.

One of the best known of the early attempts at automatic synchronizing was the Pearson synchronizer. This device consisted of two controlling magnets mounted in the same case, each magnet serving to close a contact. The two contacts were connected in series with the closing coil of an electrically-operated switch, the magnet coils being connected in parallel, and connected to the incoming machine and bus-bars in the same manner that incandescent lamps are connected in synchronizing. One of the magnets was provided with a movable iron core, retarded in its motion by a dash-pot, thus requiring an appreciable length of time to make contact, and operated to select a wave or "dark period" of the lamps of sufficient length to give the main switch time to act and still render coupling

safe. The other magnet had a free or instantaneous action adjusted to close its contact only when the voltage across the synchronizer coils corresponded to a coincidence of the phases. Thus in action, the magnet with the time element would close its contact when the difference in speed was small enough and the other magnet would complete the switch-closing circuit when the machines were in exact synchronism.

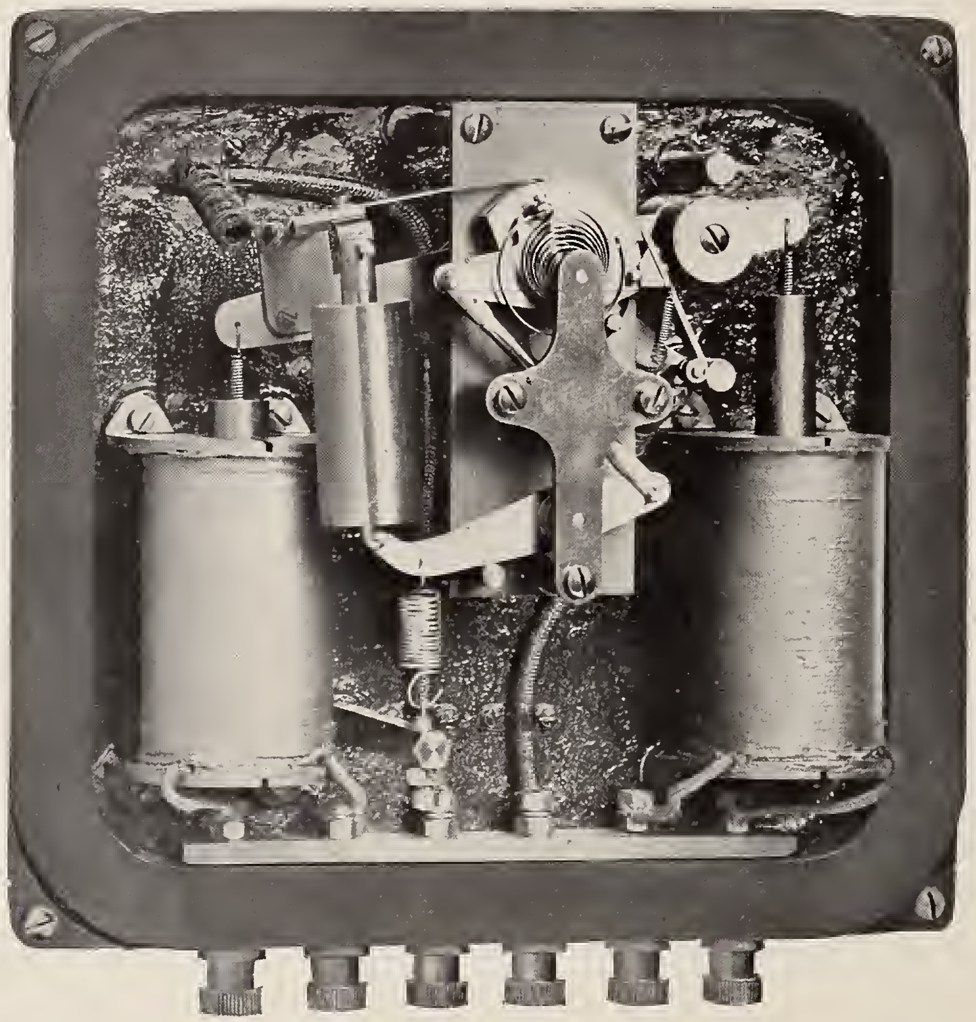


FIG. I.—A NEW AUTOMATIC SYNCHRONIZER MADE BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURG

It will be seen from the above description that the device does not fulfil all of the conditions enumerated; it makes no allowance whatever for the length of time required by the switch to act. It is true that the quick-acting contact may be adjusted to operate at a voltage corresponding to a slight difference in phase so as to make contact ahead of time, but this would mean that it could make contact for the same length of time too late; if the speed suddenly changes after the slow solenoid has closed its contact, there is danger of the second contact closing. Besides, the angular advance of the contact would not vary with differences in speeds, thus coupling the machines at too early a period when they approximated in frequency, and too late when they differed considerably, for the switch requires a constant time to close. These defects alone were sufficient to cause accidents in operation, except under particularly favourable circumstances, and thus rendered the device commercially a failure. However, the inventor deserves great credit for taking the first step in automatic synchronization, and pointing out the advantages that would accrue with a device that would infallibly do the work.

The latest development in automatic synchronizing is a new device perfected very recently by the Westinghouse Electric & Manufacturing Company, which seems to fulfil all the eight conditions above enumerated in a highly satisfactory manner. It differs entirely in its operation from the Pearson synchronizer, which was described quite fully so as to accentuate the features necessary for a successful synchronizer, as well as to throw a light on early progress. This new synchronizer, which is clearly shown in Fig. 1, consists of a pair of solenoids, each actuating a laminated iron core, supported from opposite ends of a rocker arm. Each solenoid is wound in eight separate sections, alternate sections being connected in series, thus forming two circuits in each solenoid; one circuit of each solenoid is connected in series with a circuit of the other solenoid, thus forming two independent circuits in the instrument, each circuit having half of its turns on each solenoid.

One circuit is connected to a pair of binding posts deriving current from the bus-bars, and the other circuit to binding posts connected to the incoming machine. The connections of the various sections are so made that when the incoming machine is in phase with the bus-bars the currents in the right-hand solenoid act in conjunction, thus pulling down the core, and the currents in the left-hand solenoid neutralize or cancel each other magnetically, and produce no pull. On the other hand, when the machine is in opposition to the bus-bars the currents in the right-hand solenoid neutralize, and the left-hand solenoid exerts a pull, its currents acting in conjunction.

The cores are suspended so as to reach the magnetic neutral of the coils at their extreme down stroke; thus, when the machines differ in speed, the horizontal beam rocks to and fro with a harmonic motion. As the incoming machine approaches the frequency of the bus-bars, the motion becomes slower, and finally ceases when the machines are at the same frequency; if the machines are in phase the right-hand core will stop at its lowest position, unless the voltages differ considerably, when the currents will not neutralize, and the core will not be able to reach its extreme stroke. The left end of the rocker arm carries a contact spring, marked *a* in Fig. 2, which slides along the top of a fibre segment *b*. This segment has a platinum strip *c*, on the top, which, in conjunction with the stationary spring *d*, forms the contacts of the relay circuit. The springs and contact are of such length

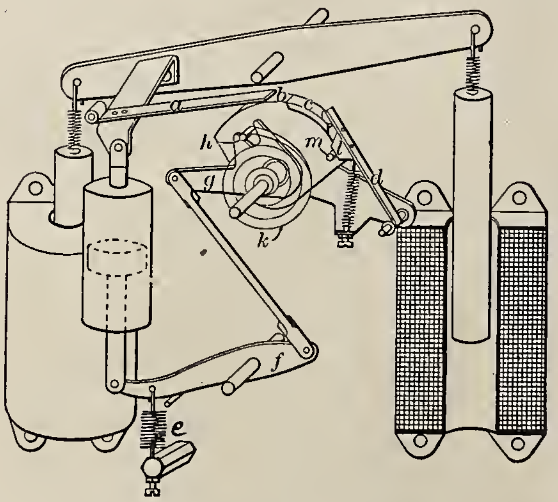


FIG. 2.—CONTACT MECHANISM

that when the segment is stationary contact can be made only when the right-hand core has reached its extreme position.

The vital characteristic of this instrument, the one that makes it successfully cover the requirements

given for automatic synchronizing not heretofore met, is the peculiar motion imparted to the contact segment. Instead of being stationary, it is pivoted on a shaft concentric with the rocker-arm shaft, which carries on its left half the chamber of a dash-pot, the motion of whose piston is opposed by a spiral spring, in the manner shown in Fig. 2.

When the left end of the rocker arm rises, it tends to lift the piston of the dash-pot, and elongate the spring *e*. Upon the return stroke a valve in the dash-pot opens, allowing a quick return motion. The piston rod of the dash-pot carries an arm *f*, which is so attached to the contact segment as to shift the latter to the left, thus advancing the position of the contact when the rocker arm moves up with a sufficient speed to draw up the dash-pot piston. The slower the motion of the rocker arm, the less the piston of the dash-pot is raised, and consequently the less the contact segment is advanced.

It will be noted from Fig. 2 that the arm *f* does not act directly on the segment, but operates a brass fork *g* between the prongs of which is a pin *h*, which is screwed into the contact segment. A spiral spring *k* between the contact segment and the fork tends to keep the pin against the right prong of the fork. The pin has thus about one-eighth of an inch of play, the purpose of which will be apparent later.

Turning our attention to the right-hand, or stationary, contact spring, it is seen in Fig. 2 that this spring carries a cam *l*, the inclined edge of which is met by the pin *m* upon the return stroke of the contact segment. This stationary contact spring is of such strength that the pin *m* cannot raise the inclined edge of the cam, for the contact segment is being actuated through the weaker spring *k*. Thus upon its return stroke the contact segment is delayed for an instant, until the left prong of the fork *g* touches the pin *h* and thus forces up the cam. As soon as the pin *m* reaches the end of the inclined plane the contact segment is free, and is snapped over by the spring *k*. The purpose of this action will be apparent later.

It will be noticed in Fig. 2 that the position of the stationary or right-hand contact spring can be varied. This, in conjunction with the adjustment of the spring *e*, is for the purpose of adjusting the difference in speed of the incoming machine at which the synchronizer will couple. Thus, when the difference in speed is too great to allow safe coupling, the dash-pot piston will advance the contact segment sufficiently to drop the stationary spring away from the contact plate and down upon the insulated portion of the contact segment *n*, thus preventing the contact from being closed when the right-hand core comes down. The retarded motion of the contact segment prevents contact being made as the right-hand core rises, allowing time for the left contact spring *a* to get out of the way.

The above description of the actions of the various parts may seem very complicated, but it must be remembered that the instrument has a very complex function to perform. Indeed, an observer of its action in actual service said that it acted in a manner almost human. It is, in fact, more reliable, quicker, and couples the machines with less surge of current than can be done by the most skillful operator. Considering this fact, it seems surprising that the proper action can be obtained with such a small number of parts. To better undertsand the operation, let us follow it in the act of synchronizing.

As the voltage of the incoming machine builds up and it approaches the approximate frequency of the bus-bars, the rocker arm oscillates violently, the dash-pot piston advancing the contact segment so far that no contact is possible, no contact being possible on the return stroke. As the speed of the incoming machine increases, the rocking becomes slower, and the dash-pot piston advances the contact segment less, until finally the right contact spring no longer drops

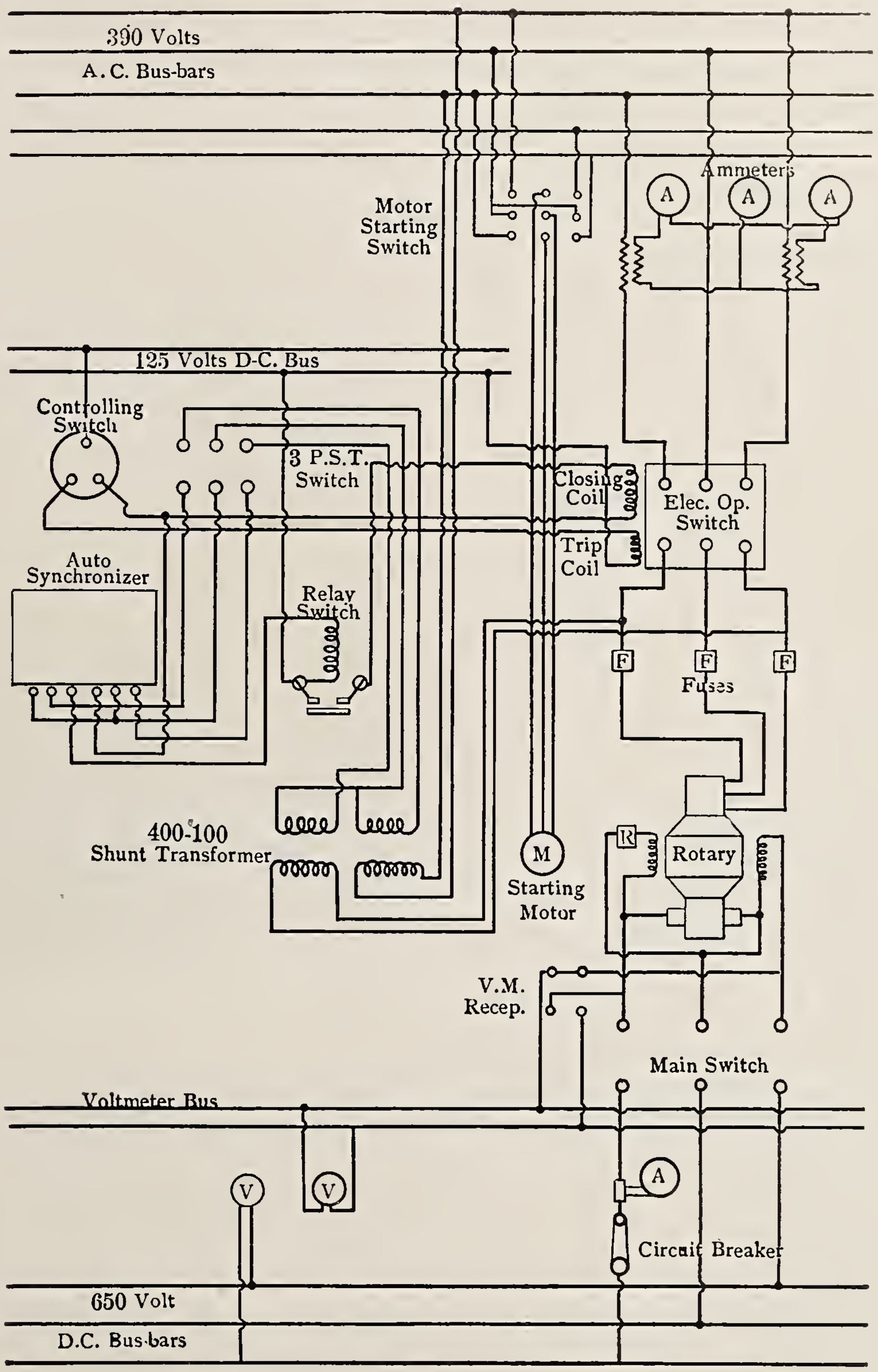


FIG. 3.—DIAGRAM OF CONNECTIONS OF A ROTARY CONVERTER EQUIPPED WITH AN AUTOMATIC SYNCHRONIZER

away from the contact, and, as the right-hand core descends, the left-hand contact spring advances to meet the contact, thus energizing the auxiliary relay, shown in Fig. 3, which operates the switch-closing circuit just sufficiently ahead of the point of coincidence of the phases, so that actual coupling takes place at the exact instant of synchronism. If the machine approaches the point of synchronism more slowly, there is less advance of the contact segment, and the actual time allowed for the switch to act is the same as before. In the extreme condition, when the machine is coming in very slowly, there is no appreciable advance of the contact segment, the dash-pot having time to exhaust. The amount of the advance of the segment can be adjusted to suit switches having different times of closing, by varying the tension of the spring *e*.

As pointed out before, the cores cannot attain their extreme position, and, therefore, the contacts cannot be closed, if the voltage is too far out for safe coupling. The auxiliary relay takes very little energy, so there is not enough sparking on the platinum contacts of the synchronizer to burn them.

Fig. 3 is a complete wiring diagram of a rotary transformer equipped with the automatic synchronizer; by means of proper synchronizing plugs, such as are used for either the lamp method or the indicating synchroscope, one automatic synchronizer can take care of any number of machines.

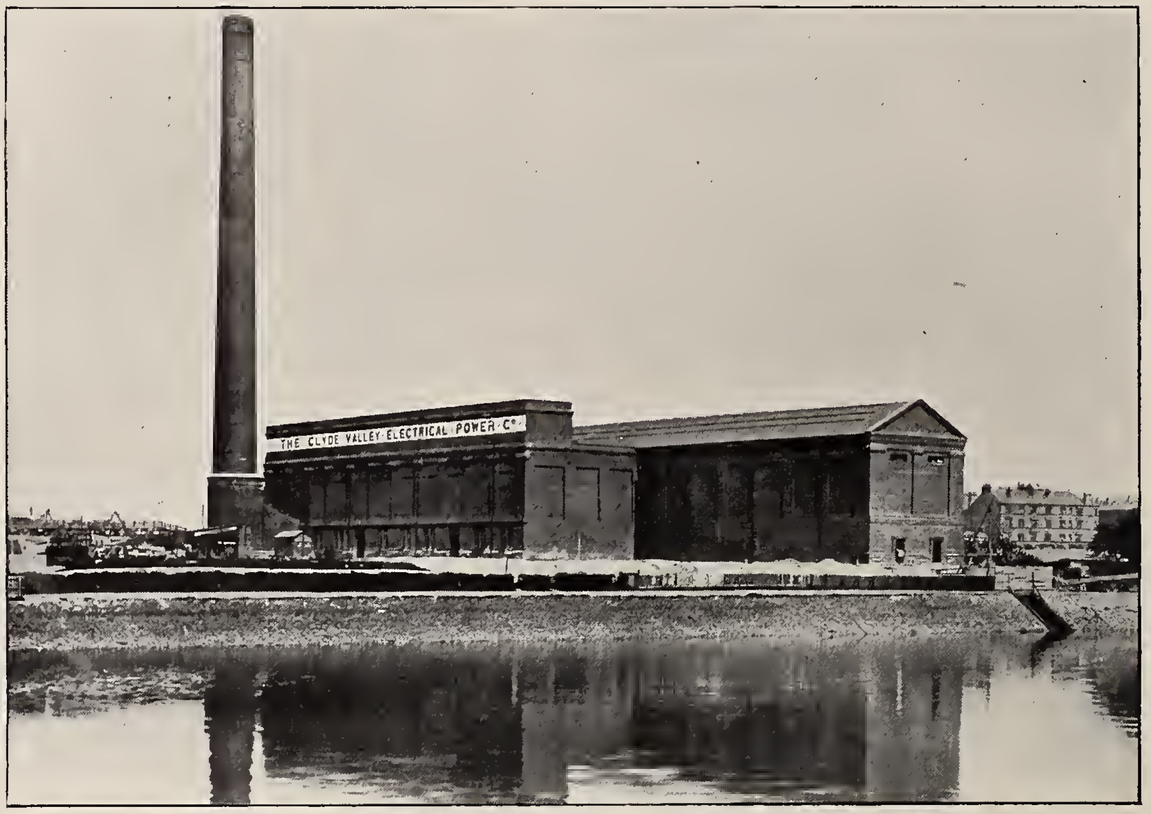
A controlling switch, such as used with oil circuit-breakers, is interposed in circuit with the synchronizer and electrically-operated switch. By means of the controlling switch, the main or electrically operated switch or oil circuit-breaker may be tripped, but cannot be closed, as the closing coil is normally out of circuit until the synchronizer completes the contact.

An automatic synchronizer would be particularly desirable in the operation of large electric railway systems. When accidents occur which entirely shut-down one or all sub-stations, it is exceedingly important to be able to start up with the least possible delay, and there has been considerable discussion lately as to the best means of starting up the rotaries. If they are started directly from the alternating-current side, a small number only can be started at once, otherwise there will be too much inductive load on the generating station. This method, therefore, requires considerable time. Starting from the direct-current side presupposes the presence of direct-current power, and necessitates a preliminary adjustment of the rheostats. However, if alternating-current starting motors are used, and an automatic synchronizer is installed for each rotary, in order to start the sub-stations it would only be necessary to throw in all the starting motors as quickly as possible, and leave the rest to the automatic synchronizers, no further attention being necessary.

The first of these synchronizers has been in actual operation at the main station of the Pittsburg, McKeesport & Connellsville Street Railway for several months successfully, and there are others in successful operation at the sub-stations of the New York Edison Company, the Manhattan Elevated Railway Company, and the Brooklyn Rapid Transit Company.

They are thus no longer an experimental device, but an assured success, and a great advance in the handling of alternating-current generators and rotaries.

Electric Power in the Clyde Valley, Scotland



THE YOKER STATION OF THE CLYDE VALLEY ELECTRICAL POWER COMPANY, ON THE CLYDE RIVER, SCOTLAND

THE Clyde Valley Electrical Power Company, Ltd., supplying current to the most important manufacturing and coal-producing district in Scotland, was incorporated by local enterprise in 1901, and obtained powers over an area comprising about 750 square miles and extending along the Clyde Valley from Craigdoran and Port Glascow in the west, to Lanark and Shotts in the east.

Under an act of Parliament the company was empowered to acquire land for the erection of generating stations at Yoker and Motherwell, 5 miles and 15 miles, respectively, out of Glasgow, and in September, 1902, a contract was entered into with the British Westinghouse Electric & Manufacturing Company for the erection and equipment of these two stations and the various sub-stations that are dotted over the area.

The Yoker and Motherwell power stations are of the same size and almost identical in arrangement, though differing in some details. The Yoker generating station is on the banks of the Clyde, where an unfailing supply of water for condensing purposes is available. The Motherwell station, situated at a higher elevation and above the level of the Clyde, depends for its water supply for condensing purposes on electric pumps working against a head of 140 feet.

The boiler house of each station is 186 feet long and 50 feet wide. At present, four double-drum Babcock & Wilcox water-tube boilers are installed, each having a heating surface of 4400 square feet and fitted with superheaters capable of imparting 150 degrees F. of superheat. The steam pressure is 175 pounds per square inch. The boilers are connected to a main flue passing along the back, and a Green's economizer of two sec-

tions and 432 10-foot tubes is installed between this flue and the chimney, the usual by-pass flue being provided. Each boiler is provided with a Roney mechanical stoker, built by the company, and driven by a 5-H. P. Westinghouse engine.

The chimney is built of special perforated and moulded bricks and is 225 feet high above the foundations, with an internal diameter at the top and bottom of 11 and 14 feet respectively. A fire-brick lining is provided up to a height of 85 feet about the top of the foundations.

The coal is brought in wagons and dumped by a hydraulic ram into a crusher pit. After crushing and screening, it is conveyed to storage bunkers over the boiler house, and then passes to the stokers, being weighed in transit.

The engine room consists of two floors, one on the ground level and one in the basement, the latter containing most of the auxiliary machinery. The main generating plant at present installed at Yoker consists of two Westinghouse-Parsons steam turbine units, each with a normal capacity of 2000 KW. and an overload capacity of 3000 KW. The speed is 1500 revolutions per minute. Each of the turbines is directly connected to a Westinghouse 2000-KW., 11,000-volt, three-phase, 25-cycle generator of the rotating-field type. These are of the normal Westinghouse design.

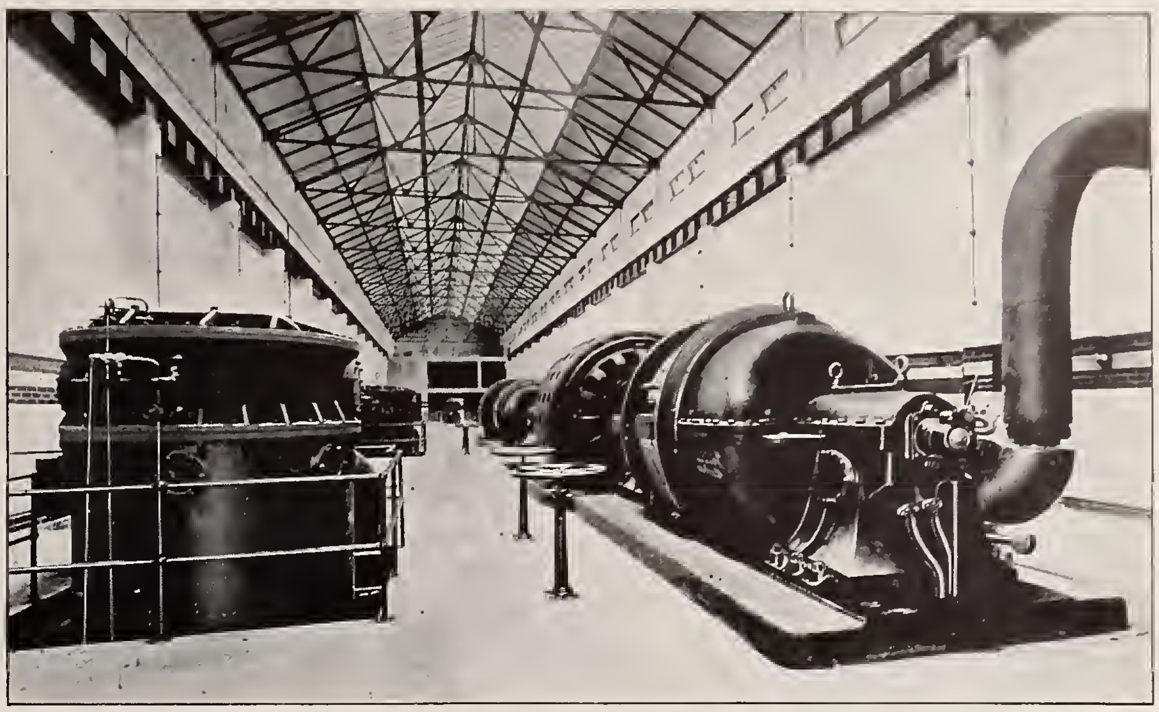
The engine room as at present constructed will accommodate one more 2000-KW. set and a fourth unit of 3500 KW., which will eventually make the total capacity of the station 9500 KW. The additional sets will be added as soon as one of the present units is loaded up, so that there will be always one spare unit ready at any moment in case of accident.

The two exciter sets, situated at the south end of the engine room, are each capable of furnishing the exciting current for both the main generating units at present installed. They are of 75-KW. capacity each, and consist of a Westinghouse 11 x 19 x 11-inch vertical compound engine, running at 290 revolutions per minute and coupled direct to a 125-volt, compound-wound dynamo. These sets also supply current for the motors of the coal and ash conveyor, crushers, agitators, economizers, pumps, traveling crane, and the like, and for the electrically operated main and other switches.

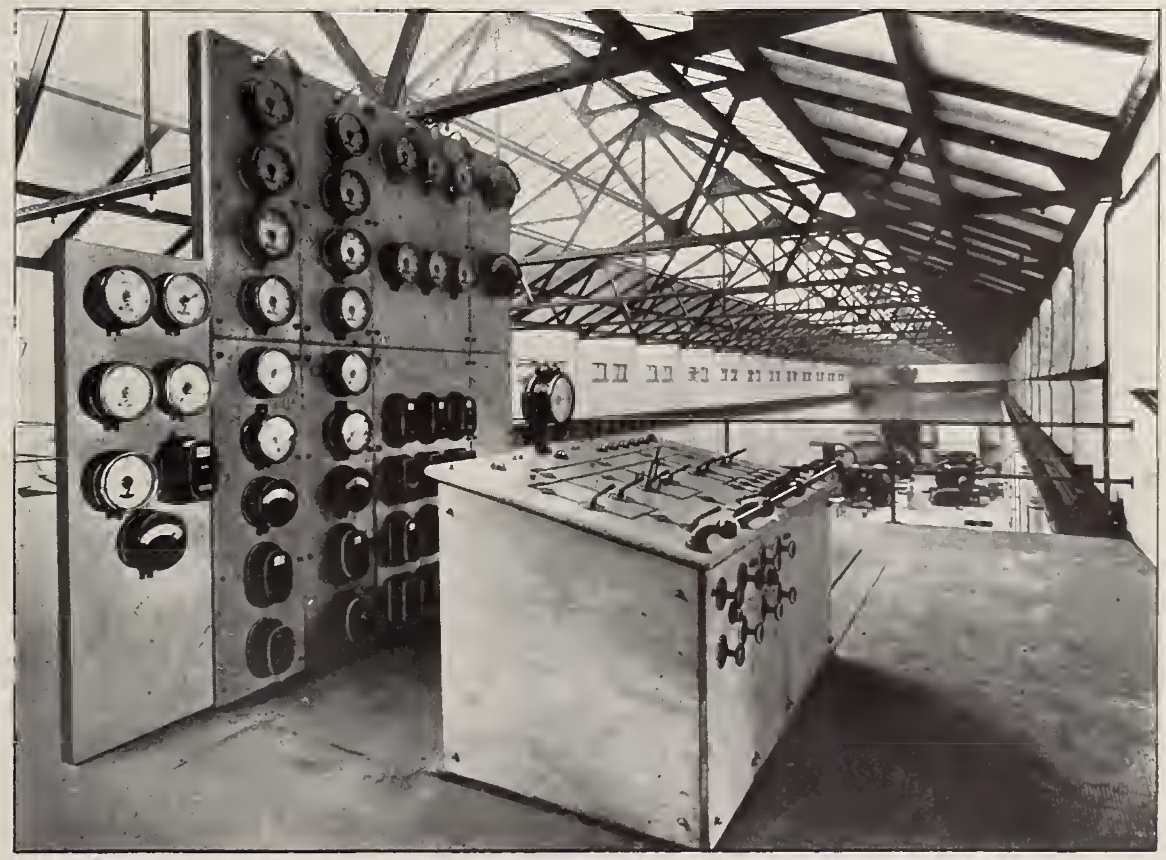
The whole of the switch gear is contained in the three galleries at the south end of the engine room. That on the ground floor and first gallery is devoted to the oil switches and feeders. On the third or top gallery of the switchboard are placed the main bus bars in brick compartments, and the main controlling board as well as the resistances, etc. Following the latest practice, the control board consists of a small desk directly facing the various instruments, such as ammeters, voltmeters, power factor indicators, relays, etc. All the main switches and smaller gear are electrically operated from this desk by the exciter current, as before mentioned, and the speed of the turbo-generators and their starting and stopping are also controlled from here.

The turbine condensers are placed in the basement, their upper ends projecting a few feet above the main floor. The circulating water is drawn from the Clyde, and the feed-water from the city mains, that of the river being unfit; a standby suction from the river is provided, however, for an emergency. The exciter sets have a separate surface condenser of the Worthington type.

The Motherwell station differs from that at Yoker in its condenser equipment. The former station is located 400 yards from and 140 feet above the level of the river, and a cooling tower for cooling 220,000 gallons per hour from 120 to 80 de-



THE TURBINE ROOM AT THE YOKER STATION OF THE CLYDE VALLEY ELECTRICAL POWER COMPANY. TWO UNITS ARE HERE INSTALLED, CONSISTING OF WESTINGHOUSE-PARSONS TURBINES DIRECT CONNECTED TO 2000-KW. GENERATORS



THE CONTROL AND INSTRUMENT BOARDS IN THE STATIONS OF THE CLYDE VALLEY ELECTRICAL POWER COMPANY

grees F. has therefore been installed. A barometric jet condenser is used in connection with two Alberger-Corliss two-stage, dry-vacuum pumps.

Six feeders are provided for distribution from Yoker, and all are protected where they enter the building in the basement by Westinghouse lightning arresters. The cables for supplying power to any part of the district between Clydebank and Scotstoun, as well as to Temple, are practically finished. They are all laid in duplicate, so that in case of any accident happening to one of them the spare one can be connected immediately while the duplicate is being repaired.

For supplying the adjacent burgh of Clydebank, a special plant has been installed at Yoker consisting of two 150-KW. motor-generator sets. Each set is provided with a small motor coupled direct to the shaft, serving for starting and running up to speed.

Both the high and low-tension cables for the Clydebank district were supplied by Messrs. Henley & Co., and the British Insulated Wire Company have been entrusted with the extra high-tension cable work throughout the entire area.

The number of sub-stations at present installed in the layout of the scheme is ten for the Motherwell district and two for Yoker. These two districts will not at present be connected in any way, although they may be in the future.

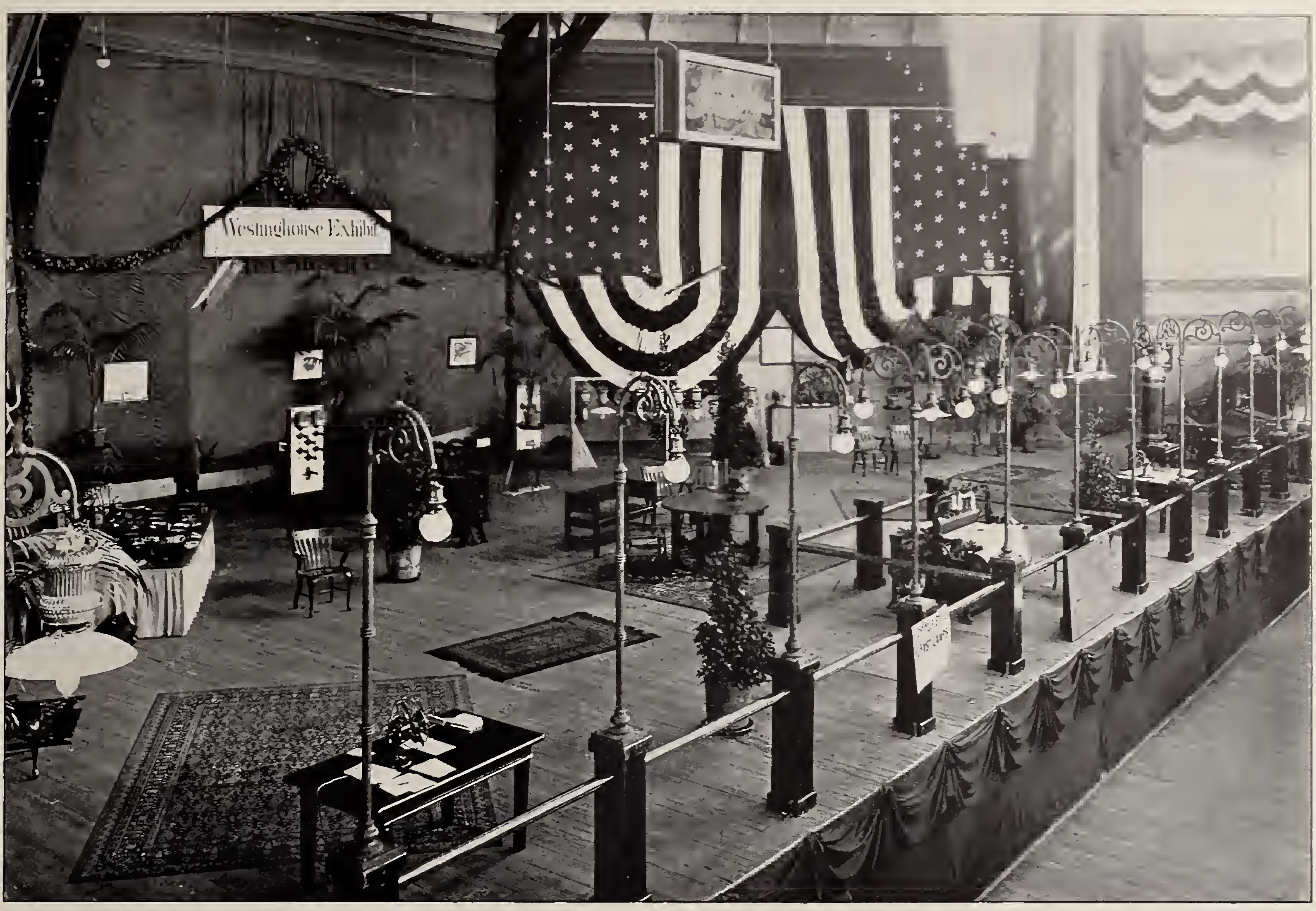
The general arrangement of the entire plant was designed by Messrs. Strain & Robertson, consulting engineers, of Glasgow. H. A. Barnett, resident engineer to the Clyde Valley Company, has had the supervision of the erection and installation of both power stations and the distribution system since the commencement.

The Recent Boston International Electrical Exhibition

At the International Electrical Exhibition held at Boston last month in connection with the meetings of the National Electrical Contractors' Association, a great variety of apparatus embodying the latest designs was displayed. While a large portion of the equipment shown should properly be classed as standard, there were a number of appliances exhibited which deserve special mention on account of their recent development or application to new fields of usefulness.

The tantalum lamp made its first public appearance in Boston in the exhibit of the Pettingell-Andrews Company, of Boston, the Nernst Lamp Company, of Pittsburg, and the Cooper Hewitt Electric Company, of New York, each exhibited their lamps, and the General Electric Company, of Schenectady, N. Y., exhibited for the first time a new high-efficiency incandescent unit designed to compete with the improved lighting devices now being so extensively developed in the electrical and gas illuminating fields. The tantalum lamp shown was operated at an efficiency of 2 watts per candle-power, the rating being 20 candle-power at 110 volts. The Nernst lamps were of the 110-volt, single, double and triple-glower types, rated respectively at 50, 100 and 170 candle-power. With the glowers mounted in spherical translucent globes supported on pedestals at the edge of the exhibit platform, the decorative qualities of these lamps were well displayed, while the usefulness of the Cooper Hewitt mercury-vapor arcs was ac-

HIGH EFFICIENCY LAMPS AND MERCURY ARC RECTIFIERS FORMED AN INTERESTING PART OF THE GENERAL ELECTRIC COMPANY'S EXHIBIT AT THE RECENT BOSTON SHOW



THE EXHIBIT OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURG, AT THE RECENT BOSTON INTERNATIONAL ELECTRICAL EXHIBITION. THE NERNST LAMP COMPANY, PITTSBURG, AND THE COOPER HEWITT ELECTRIC COMPANY, NEW YORK, ALSO EXHIBITED THEIR LAMPS IN THIS SPACE

centuated by placing four of them about 15 feet above the center of the exhibit space. It is evident that the ordinary arc lamp will find a close rival here in certain classes of factories, machine shops, warehouses, covered piers, studios, draughting and composing rooms, where a strong general illumination is required or where large areas are to be lighted.

The General Electric Company showed 32 high-efficiency lamps in operation. These lamps have metallized carbon filaments and require but 2.5 watts per candle-power. At present they are made in the 50-candle-power and 100-candle-power sizes, and either concentrating or diffusing reflectors may be used with them. The direct-current supply at 110 volts for half of the lamps was drawn from a mercury-arc rectifier of 30-amperes capacity, converting 220-volt, single-phase, alternating current to that used in the lamps. This arrangement was made simply to exhibit the use of the rectifier, as the new lamps operate on either alternating or direct-current circuits. Compared with the usual motor-generator set, the mercury-arc rectifier shows a higher efficiency and power factor, and has a lower first, as well as lower operating, cost. A 0.1-KW., 500-volt to 10-volt battery-charging motor-generator set was also exhibited by this company. A collection of small motors of various alternating and direct-current types was shown, and also a new automobile motor and standard electric motor fans. A new electric flat iron made its appearance here for the first time.

Group driving has long been accepted as the standard method of operating spinning machinery by electric motors, so that the exhibit of a direct-driven loom by the Westinghouse Electric & Manufacturing Company, of Pittsburg, attracted considerable attention. The loom was a 41-inch fine yarn cotton spinner, with a capacity of 180 picks per minute, and it was driven by a $\frac{1}{2}$-H. P., three-phase, 220-volt, 60-cycle induction motor through a suitable spur gear and pinion. It was operated each evening and illustrated the general advantages of the direct drive along the lines indicated by M. H. Merrill, in a paper read last spring before the New England Cotton Manufacturers' Association, in Boston. Automatic electric stops are provided to open the motor switch in case a thread breaks in the weaving process. In starting the loom the motor is thrown directly across the line without the use of either inductance or resistance.

Arc circuit regulators have in the past usually been of the open-coil type, exposed to mechanical injury and capable of doing harm to attendants in case of accidental contact. Equipment of this kind was exhibited at Boston by the Westinghouse Company, with an easily removed woven wire screen, which answers the requirements of ventilation and at the same time protects the transformer. Another interesting feature of this company's exhibit was a 600-KW. enclosed fuse, built to blow at 400 amperes and 1500 volts. A 20,000-volt enclosed fuse was also shown. The company also exhibited a high-tension oil switch for cutting out pole lines up to 6600 volts. In practice the switch is mounted upon a pole, so that linemen can cut out sections of the overhead cir-

cuits upon which they wish to work.

Among the large number of electric motors shown the exhibit of the Electro-Dynamic Company, of Bayonne, N. J., occupied a prominent place. A 5-H. P. "interpole" machine was shown belted to a generator which was loaded by a rheostat for the purpose of exhibiting the sparkless operation of the motor throughout its 4 to 1 speed variation of 275 to 1100 revolutions per minute and zero to 100 per cent. overload capacity. A reversing switch was installed to exhibit the same sparkless operation under rapid changes of the direction of rotation. Speeds and loads were shown upon a pair of large, illuminated-dial station instruments, one of which was calibrated to revolutions per minute and wired to a magneto belted to the generator shaft. The interpole motor is particularly adapted to the direct driving of machinery on account of the design of its speed control, and it possesses considerable interest as an example of recent development in electrical machine-tool motive power. It has already been described in the March number of The Electrical Age.

A 6-H. P., 250-volt motor with a speed range of 6 to 1, or 300 to 1800 revolutions per minute, was shown by the Ridgway Dynamo & Engine Company, of Ridgway, Pa. The successful speed control of this type of machine also depends upon the use of neutralizing coils in series with the armature. The winding on these coils surrounds the armature and neutralizes the effect of the armature reaction and prevents field distortion, building up a commutation field that prevents sparking. The speed variation is effected by shunt field resistance control, and the motor is designed to maintain approximately constant speed at all loads when adjusted for that particular speed.

Recent designs in the line of electric heaters received a notable display at the hands of the Simplex Electric Heating Company, of Boston. Electric flat irons up to 25 pounds weight were shown, the striking feature being the extended use of the automatic cut-down or cut-off switch to save current and prevent fires from the careless use of the device. Domestic heaters, stoves, broilers, milk warmers, instrument sterilizers, radiators, plate warmers, 50-watt curling iron and grease-paint heaters were displayed in varied designs. A lamb's wool heating pad was shown and its advantages over the ordinary rubber hot-water bottle emphasized. The heating pads now on the market each contain an automatic thermostat, which breaks the circuit and holds it open as long as the temperature exceeds 180 degrees F. An interesting exhibit of domestic heaters was also shown by the Prometheus Electric Company, of New York.

An interesting exhibit was prepared by C. S. Knowles, of Boston, in the line of high-tension insulators. Designs in porcelain of from 10,000 to 60,000-volt operating capacity were shown, while in glass patterns the range terminated at 40,000 volts. The Worcester Polytechnic Institute supplied a 200,000-volt transformer for testing insulators in the exhibit and performing various high-tension experiments. This transformer was built by the electrical engineering department of the Institute, and has been operated at potentials up to 300,000. The secondary contains about 20 miles of flat copper strip, 0.004-inch thick. At 60 cycles the primary is used with 220-volt current, while at 125 cycles, 110 volts are employed.

The National Carbon Company, of Cleveland, exhibited a new closed-circuit battery for railway signaling, fire alarm and telegraph service. The elements employed are zinc, caustic soda and water, and copper oxide. The electromotive force of the cell is 0.7 volt, and it has a total discharge capacity of 300 ampere-hours. It can be short-circuited without injury, and for general track circuit work it is expected that the cost of maintenance will be about 50 per cent. of that of the gravity cell. This company also showed electric light and other carbons, the largest single piece being a 6-inch cylinder, 52 inches high, for electric furnace work.

The tendency toward automatic telephone service in apartment house and certain classes of interior mercantile work was well illustrated in the exhibits of the S. H. Couch Company, the Electric Gas Lighting Company and the Couch-Seeley Company, all of Boston. New and attractive designs of telephone instruments and systems were shown by each of these companies. The automatic test system has now been extended to include 26 stations.

The D. & W. Fuse Company, of Providence, R. I., exhibited its standard enclosed fuses and subway service branch boxes, but the most interesting feature of the display was the company's "Deltabeston" wire and field coils. Railway motor field coils in all stages of construction were shown, together with samples of heat-proof wire. From the earliest period of manufacture of electrical machinery the insulation of armature, field and magnet coils has been a weak feature of construction and the cause of many failures. The chief defect in the insulation most commonly used lay in its liability to destruction from overheating, and in certain classes of machinery subject to frequent and excessive overloads, even for short periods, the serviceable life of the windings was a matter of but a few months.

Many efforts have been made to devise an insulation for the wire used in such apparatus which would not be so readily affected or destroyed by the necessary temperature rise. Asbestos has generally been used for this purpose, but until recently it has been exceedingly difficult to apply it with economy of space, and moisture repelling treatment has also been a matter of much trouble. These defects seem to have been eliminated by the exhaustive experiments of the D. & W. Fuse Company, which now supplies an asbestos-insulated wire which, as far as temperature rise goes, is practically indestructible, while at the same time the thickness of the insulation compares very favorably with that of ordinary double-cotton-covered insulation.

Investigation has shown that at a temperature of about 147 degrees C. cotton-covered wire will in time char to an extent that will finally break down its insulation. It was further ascertained that at 199 degrees C. cotton-covered wire began to smoke in 20 seconds. At 239 degrees C. it was distinctly discolored in 50 seconds, and complete carburization had taken place at 245 degrees C. in 2 minutes, 15 seconds. These temperatures are, of course, excessive, yet they go to show how short a time is necessary to ruin the field or armature windings of a railway motor, subjected as they are at times to enormous overloads. Deltabeston wire, tested under the same conditions and subjected to the same volume of current, has proved to be absolutely unaffected.

An interesting comparative test of the properties of the two wires was made in the exhibit by coupling two pieces together and subjecting them to the same current, resulting in the complete destruction of the cotton insulation without affecting the Deltabeston wire in the slightest. Deltabeston wire was also run at a dull-red heat, representing a temperature in the neighborhood of 600 degrees C. without its insulation being destroyed. Since the temperature rise in any motor or dynamo is limited by the sparking limit of the commutator, it is doubtful if, under any service conditions, the temperature can

be brought to a point high enough to break down the insulation.

One coil shown had been taken from a railway motor in which the outer insulation of the cotton had been burned away. The Deltabeston wire covering was uninjured and the coil proper in perfect shape for rewinding. Another coil showed an insulation resistance of over 400 megohms after having been heated to 900 degrees F. for four days and then immersed in water. Deltabeston wire is at present supplied in sizes from Nos. 4 to 18, B. & S. gauge.

An interesting list of 101 uses to which circular-loom conduit can be put with advantage was compiled by the American Circular Loom Company, of Chelsea, Mass. While many of these are familiar to users of flexible conduit, a number of them are of special interest on account of the wide range of usefulness which they indicate. Some of the more prominent are in connection with separate bus bars too close to metal framework; separate wires in contact with woodwork or metal frames in cut-out cabinets; on service wires as a protection from cornices, and on guard wires on tops of buildings; on wires in unlined pipe used as bushings; on high-tension wires near walls, ceilings or other wires; on wires crossing brick or stone work; on portable wires to all kinds of iron machinery, and to motors and lights in show windows; on wires in electric signs, and wires cleated to wood or metal work in showcases; on flexible connections in railway cars, portable wires to electric flat irons and heaters, and in pits of car houses.

A novel application of electricity to showcase work was exhibited by the Thompson-Bonney Company, of New York. The showcase was of the revolving, window-display type, equipped with plate-glass trays and driven by a 1-20-H. P. motor. A variegated cylinder extending the full length of the case at the bottom also formed part of the equipment. When the current is on, the trays, with their contents, miniature electric lamps which illuminate them, and the automatically changed colored cylinder, all move noiselessly, effecting a brilliant display of the goods in conjunction with a changeable illuminated sign. The attraction and capacity of such cases are apparent to any one who is familiar with the crowded condition of the retail stores during the bargain rush hours. It is difficult for merchants to maintain enough employees to properly display their wares during these times.

A case 5 feet long contains 1920 square inches of display space, and with the new equipment is particularly adapted to the use of jewelry stores, drug stores, sundry, shoe, hat, dry-goods, hardware, furnishing and stationery houses. This equipment was shown for the first time at the International Exhibition. Another appliance exhibited by this company was an emergency connector for cutting in a testing meter at a consumer's establishment. It consists of a copper casting with binding posts at each side for the line connections, two leads for the testing connection and a plug for short-circuiting the latter under ordinary service conditions. The device is designed to save the trouble and expense of cutting open a consumer's circuit for meter testing, and it eliminates the annoyance and cost of interrupted service in busy establishments.

Several automobile spark plugs were shown in operation at the exhibition. These were generally supplied with current by a magneto generator driven by a 1-8 to 1-6 H. P. 110-volt motor, the magneto circuit being wired in series with a spark coil. Make-and-break, jump-spark and wipe-spark plugs were shown by the Stuart-Howland Company, of Boston.

A mercury-break interrupter for induction coil primaries was shown by the Heinze Electric Company, of Boston. The apparatus was motor driven and was capable of breaking the circuit in .000011 second. By adjusting the frequency of the breaks the interrupter was shown as a theater dimmer which operates with vast economy of energy in comparison with the ordinary rheostatic methods. Any one who has rapidly made and broken an incandescent lamp circuit by hand and observed the variation in brilliancy which results from longer or shorter contacts readily appreciates the possibilities of machine interruption.

A steam turbine of 1-KW. rating was shown by C. L. Garrison, of Boston, the normal speed being 25,000 revolutions per minute. The compactness of this machine was unusually noteworthy.

Dunton & Field, of Cambridge, Mass., exhibited a tree insulator of novel design, so constructed that it can be used with any size of wire. It consists of a malleable-iron arm with a cone-shaped casting pivoted to its lower end. A standard locust pin is driven into the casting and the insulator is mounted upon this. The malleable-iron arm swings on a sleeve which is lag-screwed to the limb of the tree. The insulator consequently allows the limb of the tree to move in any direction without injury to the tree or wire; there is no place on a tree where the insulator cannot be attached, and the wire insulation is protected from wear.

Properties of Tantalum

THE characteristics of tantalum as a filament for incandescent lamp use have already been mentioned in these pages, but the metal possesses other properties which are of interest.

At a recent meeting of the German Bunsen Society, Dr. Werner von Bolton said that if the metal contained unaltered oxide its hardness was greatly increased, and it was harder than the diamond. Since such an oxide-holding metal is tougher than the best hardened steel, it would form an almost perfect protective metal for warships if the cost did not make this out of the question.

Tantalum is of interest to the electrochemist by reason of its assumption of the passive state under certain conditions. A cell composed of two electrodes of this metal, with sulphuric acid as electrolyte, will not allow an alternating current of even 120 volts to pass. By substituting platinum for tantalum as one electrode, current is allowed to pass in one direction only, and such a cell can therefore be used as a current rectifier.

Tantalum, at a red heat, decomposes water and burns with evolution of hydrogen. A fine wire of the metal, ignited by a match, burns slowly in the air, forming pentoxide.

Among the few American inventions which are on display at the Naval, Shipping and Fisheries Exhibition at Earl's Court, London, this summer, a full-size working exhibit, made by the Long-Arm System Company, of Cleveland, Ohio, of the "Long-Arm" system of electrically-operated water-tight power doors has attracted great attention from naval men who have visited the display. This system, already described in the March, 1905, issue of this paper, from a central station located at a convenient point on the bridge of the ship, closes the doors and hatches of the vessel in time of emergency, providing for the local safely of men involved by a liberty action attached to each door. The device has been installed on about thirty American men-of-war, and the admiralty departments of several foreign governments are interesting themselves in the system with a view to placing it on their ships.

From the World's Technical Press

Cement-Coated Wooden Poles for Electrical Service

ACCORDING to "The Schweizerische Elektrotechnische Zeitschrift," wooden poles, completely covered with a 1½ to 2-inch layer of cement, have been tried and experimented with for the last three years. During this time they have proved entirely satisfactory, and it is hoped that they will be as durable as well-kept iron poles, over which they have the advantage of cheapness. The wooden pole is first surrounded by a wire netting supported from the pole by suitable iron brackets and iron bars. After this has been done the whole of the pole is covered with cement to the thickness mentioned. Such cement-covered wooden poles, in lengths of 39 feet, 42½ feet and 46 feet, have been employed by the Zurich electrical works.

Imagination in Engineering

IT is one thing to solve a problem which is definitely stated, says Chas. F. Scott, in "The Electric Club Journal," but it is quite another matter to formulate the problem from a lot of promiscuous data. It is one thing to design and assemble apparatus to meet specific requirements; it is quite another to decide what are the actual requirements to be met, or what will be the demands, when new methods produce new conditions.

The larger engineering problems involve indefinite data, and greater ability is required in their formulation than in their solution; they project into the future and must anticipate conditions for which there is no precedent.

For many years the increase in Bell telephone subscribers was about 10 per cent. per annum. For the past five years it has averaged 29 per cent. The number of subscribers' stations added last year was greater than the total number in 1897, after 21 years of growth. Should the engineer in laying out conduits and pole lines and switchboards provide for a continual doubling of subscribers every three years?

The street railway facilities in our large cities present a record which would be ludicrous were it not so serious. The horse cars gave place to electric systems of large and rapid cars, but the crowding becomes denser. In Boston a subway was accepted as the solution, but passengers came faster than facilities; an elevated road was added and the subway was reconstructed to admit the larger cars; the facilities were still insufficient and the platforms were reconstructed for longer trains. In New York with its extended surface system, its elevated roads and new subway, it may be questioned whether the probability of getting a seat was not better in horse car days than it is at present.

Telephony and traction are not simple self-contained problems; they react on social and business life. People form new habits. The more they talk and travel, the more they need to talk and travel. The telephone—the high-speed tool of the business world—intensifies activity and requires more telephones. Facilities for travel induce more travel. The telephone and the electric car are not passive elements in modern progress—they are active accelerating forces which increase its rate.

What is true in larger things prevails in smaller ones as well. Some time ago a motor was to be placed in a sawmill. Measurements indicated a trifle over 20 H. P. was being used. A 30-H. P. motor was installed. A year later the investigation of a complaint showed an actual output of nearly 40 H. P. and the motor was replaced by another of 50 H. P. When there was a reliable motor behind the saw it was discovered that an increased rate of feed was possible and the output of mill and of motor were far more than anticipated.

Many electric plants—central station, railway, transmission, industrial—have required not merely increase, but reconstruction and change of system or method, because the original provision for development was entirely inadequate as the future had not been correctly gauged.

Imagination is essential to the engineer—a constructive, creative imagination, tempered by experience and level-headed judgment, which can anticipate conditions not known to experience and foresee the means of meeting them. The engineer who cannot see beyond the present is not a safe guide.

Electrically-Operated Swing Bridges

IN Sydney harbor, in New South Wales, says "The Electrical Review," of London, are two swing bridges which are operated entirely by electric motors. The latter are supplied with 500-volt direct current from the tramway system. The slewing is effected by two series-wound motors with series-parallel control (one being of sufficient power to perform the operation if necessary), taking 89 H. P. maximum to open the bridge in 30 seconds, or 15 H. P. maximum, if the motion is spread over 60 seconds. The average time taken in practice is 50 seconds.

In order to counteract the deflection of 3½ inches on the ends of the

bridge when hanging free of the abutment piers, the ends are raised 1¼ inches by a cam motion attached to a shaft running the length of the bridge under each of the two main girders, and operated by a motor when closing the bridge. This partial lift also prevents chattering of the bridge when heavy loads are passing over it. The operation of lifting the ends takes 15 seconds, the motion being stopped by an automatic circuit-breaker and solenoid brake attached to the motor, and operating when the correct lift has been made.

Each of the four gates closing the ends of the abutment piers to traffic when the swing bridge is open, is operated by a slotted crank motion, driven by a 5-H. P. motor. Twenty-five arc lamps, some of which are provided with ruby glass warning-signals for mariners, complete the electrical equipment, which is controlled from a house situated above the footpath at the center of the span. This contains the necessary controllers, switches, circuit-breakers and ammeters, and dial indicators showing the operator the position of the swing span and end lifts at any moment.

Electrically-Driven Air Compressors

THE motor-driven compressor, says L. I. Wightman, in "Mines and Minerals," must be looked upon as distinct a unit as the steam-driven air compressor. It must not be considered or treated as a mere temporary combination of two distinct machines, an electric motor and a power-driven air compressor; but the two must be united into a distinct individuality, the peculiarities of which offer a problem at once interesting and perplexing. The electrical compressor unit proper is made of three distinct elements—the motor, the compressor and the method of drive or connection between them. As the driving element, the motor should properly receive first attention.

The type of motor will be determined by the character of the electric current available. If the power is delivered to the compressor plant from a direct-current source, a slow or moderate speed direct-current motor will be used. Such a motor may be operated at variable speed by means of some of the well-known methods of speed control; but this is a contingency which need not be considered in the average mining plant. For while the mine load is a variable one, speed variation cannot be economically secured in a motor by electrical means, and fluctuations of load can be much more efficiently cared for by some of the standard motors which operate at a constant speed assisted by regulators, than by a variation of piston speed and displacement.

When circumstances compel the use of an alternating-current motor, the choice is usually offered between two types: the synchronous motor and the induction motor. The synchronous motor, however, is open to the objections that it is not self-starting under load, that it requires direct current for field excitation, that it is liable to get out of step and stop, and that with variation in the load the power factor also varies.

The other type of alternating-current motor—the induction motor—has characteristics which seem to fit it peculiarly for the arduous services of the isolated mining plant. In the first place it is about as tough and sturdy a piece of machinery as the field of engineering affords. It may be overloaded to a standstill without burning out or other injury. It is devoid of any delicate parts; it is practically "fool proof." In operation it has no evil effects upon the transmission system, except that when started under load it may require a starting current six or eight times the normal running current, resulting in momentary inrush which has a serious unbalancing effect on the line. But it is never necessary to start a mine compressor under load; and under normal conditions a motor properly designed for the service will start with a current but very little in excess of its normal running value.

The induction motor is self-starting and its speed is practically constant, the greatest variation from normal seldom being more than 5 per cent. Principles inherent in its design cause it to slow down very gradually as load comes upon it until the slip is such that the currents induced in the rotor are sufficient to carry the load. In this respect it is self-governing and this fact, combined with its sturdy structure and remarkable endurance, makes it almost the ideal motor for heavy and continuous service in regions remote from shop facilities, or in the hands of unskilled attendants.

An Electric Automobile Bank

WE have for so long had it dinned in our ears, says "The Automobile Magazine," poked in our eyes and jammed down our throats, all about how it takes a bank to buy and another one to keep an automobile, that now the much-despised vehicle is to become after a fashion a bank itself, we hope the calamity howlers will let up for a while. The new vehicle has been designed for the officers of the Cincinnati Cosmopolitan Bank by two of the bank's officers, who have taken out patents on the vehicle. The car is an electric one and is to be built of chilled steel, with double walls, with a 1-inch space between them. In one corner is located a burglar-proof safe, while desk and working room for several clerks are also provided. The car has a touring radius of 50 miles, and will cost over $5000 to build. When completed the car will be used by the bank in collecting from customers, especially at night from shopkeepers. It will also be sent to various parts of the city to receive deposits of commercial and savings accounts. This can be done with perfect safety since the vehicle will be absolutely burglar-proof, even the grilled window of the teller being provided with steel sliding shutters. In the days to come imagine what will happen when a festive bank cashier with a shortage in his accounts and an automobile loaded with collections makes up his mind that it is a case of Canada for his.

Soldering Copper Conductors

IN the "Electric Club Journal" appear the following notes on soldering copper conductors:—

Cleanliness and heat are essentials for a good soldered joint. In making an ordinary spliced joint, the wires are each bared of insulation for a distance of about one inch from the joint and carefully cleaned by the use of sand paper or emery cloth. The emery cloth is preferable because it is so tough and flexible that a rapid scouring of the surface can be made.

The two ends of the cleaned wire are butted together after slipping over them a carefully cleaned sleeve. The surfaces may be brushed with a solution of sal ammoniac, or, what is preferable, coated with a soldering paste. A solution of resin in alcohol is sometimes employed for this purpose. The joint is now ready for the application of the solder. It is heated by a hot soldering iron or in the flame of a hand-torch until the application of a soldering stick to its surface shows that the solder will readily flow over the cleaned surfaces. Certain precautions must be observed in heating the joint, as, for instance, not to get the surface too hot, as the copper will then oxidize. Neither must the surface be too cold, as the solder will not then readily flow, as a consequence of which the joint may be

imperfectly united, or, because of frozen drippings, it will present stalactitic points which have to be cut or filed off before tapping the joint. It is absolutely necessary that the soldered joint have a smooth surface, otherwise the insulation will be cut.

If, however, the joint need not have mechanical strength and is only required to be electrically conducting, the use of a sleeve may be dispensed with. The wires may then be placed side by side, overlapping and wrapped with fine copper wire, about No. 26 in size. The fine wire holds the joint in position. Care should be used in wrapping that the wrapped wire presents no sharp points. Solder is now flowed on as before. After a sufficient amount has been put on to cover the surface, and the interstices of the fine wire are filled, it is advisable to wipe the joint with a cloth just as a plumber does in wiping a joint. This removes any excess of solder and makes the joint smooth on its surface.

If the conductor is two wires in multiple and it is desired to solder it to a similar pair of wires, it is usual to cut one wire of each pair half an inch to an inch shorter than the other and then place the two conductors together. These may be wrapped as above, and their soldering presents no difficulty. Obviously, this may be extended to the soldering of any number of conductors in parallel.

It is sometimes necessary to solder a sheet copper strip to a wire in order to provide a flexible lead for wires of large size. After the surfaces are cleaned, one end of the copper strip is formed to fit the wire to which it is to be soldered. After fluxing, the soldering operation is performed as usual. If a single copper strip does not provide sufficient conductivity for a wire cable, two or more of them are placed in parallel upon it, in which case difficulty is apt to be experienced from the flowing of solder between the strips.

Solder will always run on hot copper. To obviate this difficulty it is usual to place strips of material between the sheets of copper to prevent their being united by the flowing solder.

Copper wire up to the size of No. 0 may readily be soldered by a soldering iron of the usual size,—say an inch and a quarter square. With larger sizes a torch must be used unless one has a pot of hot solder with a couple of ladles, when the hot solder may be poured from the ladle directly on the joint. This can be accomplished by pouring upon the joint and catching the drip in the ladle underneath the joint. If the joint is of such a size that it is not warmed at the first pouring, the lower ladle may be brought over the joint and a second pouring may be made. This process is to be continued until the joint is thoroughly hot, which will be apparent from the fluidity of the molten solder running through it. If a sufficient amount of solder is not retained in the joint, as may happen if the joint is too hot, it may be filled in from a small stick of solder and then wiped as it cools to secure the requisite smoothness.

In soldering one cable to another cable it is usual to interleave the fine wires to a sufficient length and then wrap the whole with fine wire, after which it may be treated in the usual way. When a cable is to be inserted in a sleeve or a terminal plug it may be dipped in the soldering fluid and then plunged into molten solder. The plug in which the cable may be placed can be tinned in the same manner. The receptacle of the plug is now filled about half full of solder, when the tinned cable may be plunged into it. The parts should be solidly in position and remain undisturbed until cooling has taken place.

Electricity and Fire Insurance

MR. A. H. MAYES in an article on electricity and fire insurance in "The Electrical Engineer," of London, says:—We are confronted by an element of danger in the form of resistances as used for starting and speed-regulating purposes. Proper precautions would reduce the fire risk to practically nil, but, unfortunately, great carelessness is often displayed in the method of fixing and protecting these pieces of apparatus. A short time since, the writer was inspecting a large motor installation in London, and found gross carelessness displayed in the above matter. A 25-H. P. starting resistance of the wire coil type had been arranged to stand upon the cement floor in the basement, and as the sheet-iron case containing the coils was open at the bottom, a quantity of waste paper and rubbish had gradually worked its way underneath, and actually found its resting place amongst the coils. The above apparatus should certainly have been fixed about a foot from the ground, and have been provided with a perforated iron bottom.

In several other instances it was found that starting resistances were quite unequal to the demands made upon them, having insufficient carrying capacity, and often attaining a red heat in operation. More care was, therefore, essential in selecting a starting resistance suitable for the particular work to be performed. It may be added that the switch and resistance should always be enclosed in an outer case of strong sheet steel which is an adjunct of a very necessary character on account of the fact that a considerable amount of sparking takes place upon the switch contacts, and particles of molten metal are at times thrown off. Main switches should most certainly be enclosed in cast-iron cases, as they are frequently liable to rough handling, and it often happens that an arc is set up owing to defective action.

Another important adjunct to power installations is the fuse, and unless a proper type be employed it is undoubtedly a source of fire risk. Whether the open or enclosed type of fuse be selected, there are two points of the greatest importance to be observed—that is, that the terminals shall be an ample distance apart, and the device shall be enclosed in a cast-iron case.

If proper attention were paid to these simple points the fire risk would be reduced, and would bring still nearer the day when fire insurance companies will be compelled to admit that electricity is by far the safest agent to employ for both lighting and power.

Graphophone Records Through a Telephone

AN interesting experiment was recently carried out in Chicago at a mercantile exhibition. It was that of making a graphophone record with telephone connections. The experimenters were C. G. Gillum, of the Columbia Phonograph Company, of New York, and J. C. Presnell, of the Chicago Writing Machine Company.

The connection between the telephone and the graphophone was described in "The American Telephone Journal" as having been of the crudest form. The receiver of the telephone was held to the speaking tube of the graphophone. A march was played by the Seventh Regiment Band, which was located in the balcony at the extreme north end of the Coliseum, and recorded on the cylinder of the graphophone at the extreme south end. There was no special arrangement to concentrate the sound into the transmitter of the telephone, a megaphone only being used. The record obtained was loud enough to be reproduced again over the telephone and be distinctly heard. The results were very satisfactory.

Mr. Gillum also dictated a letter over the telephone to the graphophone and succeeded in getting the dictation clearly enough to have a typewritten transcript taken from the record. In this way, it has been demonstrated that, with the use of the transmitter and receiver made by the Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., together with the adjustaphone and the Columbia Phonograph Company's graphophone, it is possible to dictate letters over the telephone to the graphophone. It is stated that the experiments are being continued, and in a short time the telephone-graphophone attachment will be upon the market.

Electrical Mine Equipment in South Africa

ONE of the outstanding features in South Africa of modern gold mining methods, and also of coal, tin, etc., says "The Iron Age," has been the remarkable increase in the demand for electrically-driven machinery for all purposes. Hauling, lifting, pumping and lighting are fast being accomplished by the use of electricity, each of which, it can be readily seen, requires an enormous expenditure to adequately provide the necessary plant. For lifting purposes a motor of the three-phase induction type, working at a pressure of 500 volts, is a representative one, and is capable of driving 125 H. P. Where the depth is moderate, 50-H. P. motors are frequently employed.

There is just now quite a craze among South African mining engineers for the newest and best electric plants for hauling and lifting purposes. Pumping is gradually being performed by means of electric power, the well-known centrifugal pumps being largely used. These are also driven by steam power, oil motors and turbines, and are a vital necessity to many mines. For lighting purposes a vast and ever-increasing supply of plant and fittings is required, forming in itself no inconsiderable portion of the expenditure account.

New Fields for Inventors

THE common glass insulator adapted to telegraph and telephone lines has been in use for nearly fifty years without any variation in its construction, yet it is certainly an antiquated device for answering the purpose of modern pole telegraph construction. To string the wires upon these round insulators which are provided with a circular groove it is necessary for the lineman to securely fasten the continuous wire to the insulator by means of locking it to the insulator with a short piece of wire, used as a binder. The work of attaching the wires to this type of insulator is slow and expensive. What is needed in this particular line, suggests "The American Inventor," is an improved insulator to which the wire may be attached and locked with but little labour. The prime consideration, however, is that it can be manufactured cheaply.

With the increasing popularity of electric trolley lines it may be also suggested that an improved insulating device for holding the trolley wire would be a profitable field for a successful invention.

The Future Supply of Rubber

ONLY two sources of rubber supply deserve serious consideration, says H. L. Terry, in "The Electrical Review," of London. One is what nature has provided in the tropical and sub-tropical regions, and the other is the plantations which, in rapidly increasing numbers, are found in Ceylon, the Straits Settlements, Mexico, Central America and other places.

The bulk of raw rubber comes to the world's factories from Brazil and the Congo region, the main point with regard to future supplies being that in Brazil the product is obtained by merely tapping the trees without affecting their vitality, while in Africa the tree, which is a kind of creeper, is cut down and destroyed in the gathering process. It will be recognized then that, without replanting, it is only a matter of time for total exhaustion in the principal yielding grounds of West Africa; on the other hand, the Hevea braziliensis, which may be named as a typical South American tree, continues to yield year by year, thus requiring practically no oversight or capital outlay.

That there is still plenty of this Brazilian rubber, which is of a much higher quality than the African, to be had for the gathering admits of no doubt. The difficulty is to get sufficient labour to gather it in order to keep up with the constantly increasing demand. Progress has been made, however, in increasing the Brazilian output. It has taken only five years to show a rise from 22,000 tons to 30,000 tons.

Though it is still rather early to arrive at a correct estimate of the profits of rubber planting, it appears to be the fact that, given favourable conditions, the Para rubber tree can be grown in Ceylon and the Straits Settlements at a cost of 50 cents per pound of pure rubber. Indeed, one authority gives it as his experience that it can be grown for 29 cents per pound, but this has not found general corroboration. Supposing, therefore, that we take the higher figure of cost, it is clear that at the present selling price of Para rubber ($1.39 per pound) the profits are very large.

Plantation-grown rubber fetches a higher price in the market than the product of Brazil on account of its freedom from water. There does not seem any ground to suppose that it is intrinsically superior, though some aver that it is. On the contrary, it is quite probable that, owing to the tapping of immature trees, or the effect of climatic conditions which differ from those in Brazil, deterioration may show itself. At present the preparation of the rubber from the latex, or milk, is carried out on the plantations under more skillful management than is the case in Brazil, where the gatherers are under no scientific supervision. In Mexico and Central America the indigenous tree, the Castilloa, is being extensively planted, and there is no good reason to doubt of satisfactory results being obtained. In this connection it may not be superfluous to say a word as to relative quality. The product of the Castilloa trees is a good rubber, and under cultivation it will, doubtless, command higher values in the market than it has done in the past when prepared by the natives without supervision. At the same time there is no ground for supposing that this rubber will equal Para rubber in price, as has been asserted in connection with the flotation of some companies. Exaggerated statements of this sort ought to be refuted as soon as possible, as they can only have the ultimate result of bringing discredit upon the rubber-planting movement generally.

The Magnetic Properties of Cast Iron

ACCORDING to "Stahl und Eisen," experiments by H. Nathusias with samples of cast iron of different composition showed that the presence of manganese in the metal increases the hysteresis loss, and that, as is already known to be the case with steel and wrought iron, increasing proportions of carbon, especially of combined carbon, have a very bad effect.

There is also a relationship between the hysteresis loss and the amount of silicon in the iron. Hence, in order to obtain a good magnetic cast iron, the materials of the melt must be so arranged that the quantity of sulphur and of phosphorus shall be normal, that of manganese as small as possible, that of silicon as large as possible, that of total carbon as small as possible, and that of combined carbon reduced to the minimum. In order to avoid porosity, the metal should be blown with a powerful wind pressure and poured very hot.

The electrical resistance of cast iron is from 0.9 to 1.9 ohm per metre and per square millimetre; and, therefore, it should be used for those portions of dynamos in which losses due to Foucault currents are conspicuous. The specific resistivity of cast iron is the greater the more foreign elements are present in the metal, and the larger the proportion of it they form. The author considers that cast iron might be employed in place of cast steel for electro-technical purposes, on account of its higher resistivity, greater fusibility and lower cost.

United States Naval Wireless Telegraph Experiments

In the experiments being made by the United States Navy with the several systems of wireless telegraphy, says "The Army and Navy Journal," the best results are not being obtained through the use of any one system, but by the use of receivers of one and transmitters of another. For this reason it now appears rather unlikely that any one distinctive system will be officially adopted by the Navy. It is more probable that some combination system will be gotten up.

As far as this Government knows, the United States Navy in its recent experiments has attained better results in sending and receiving wireless messages than any navy in the world. Admiral Manney, chief of the Bureau of Equipment, has received recently a report from the battleship Maine, stating that that ship exchanged messages with a station on shore at a distance of at least 300 miles. Remarkable results have also been reported to the Bureau of Equipment by other ships of the North Atlantic station.

On the recent cruise of Admiral Sigsbee's fleet to France, messages sent from a shore station were read on the flagship Brooklyn at night at a distance of 1100 miles at sea. It was not possible, however, for the fleet to talk back at this distance. The longest distance at which messages were read during the day was 540 miles. When the messages were read at 1100 miles distance they were very strong and distinct, indicating that probably they could have been read at a much greater distance. The next two days, however, were Friday and Saturday, on which messages are seldom sent from the station from which the ships were receiving, and nothing was heard.

A German Device for Flicker Advertisements

An interesting device for making and breaking the circuits of incandescent lamps used in advertising signs was recently described in the "Elektrotechnische Zeitschrift." A diagram of the circuit-breaking arrangement is shown in the annexed illustration.

The device is made by the Allgemeine Elektricitäts Gesellschaft, of

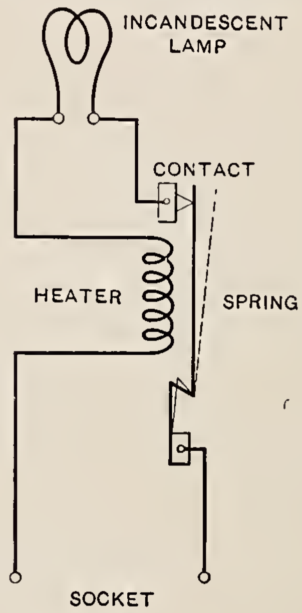


DIAGRAM OF CONNECTIONS FOR A CIRCUIT MAKING AND BREAKING DEVICE USED IN ADVERTISING SIGNS

Berlin. It is in the form of a lamp socket, with one end suitable for insertion into an ordinary incandescent lamp-holder, and the other end arranged to take the lamp itself. The socket contains a circuit-breaking device, as shown in the diagram. This circuit-breaker consists of a small heater similar to the heating spiral of a Nernst lamp, and a Bregnet spring made up of two thin strips of dissimilar metals welded together. The two metals are chosen so as to have distinctly different coefficients of expansion, and in the cold state the spring is upright and closes the circuit, as shown.

As soon as the lamp is inserted the current passes through the heater and the spring and causes the spring to bend into the dotted position, and so break the circuit. The spring then immediately commences to cool, and again closes the circuit. This cycle of operations repeats itself automatically at regular short intervals, and if a number of lamps fitted with the device are arranged to form an advertisement, a novel and attractive effect is produced, for, though all the lamps repeat the cycle in the same time, they do not all light up or become extinguished at the same instant.

Shunt Motors for Electric Cranes

The advantages which the shunt motor offers for driving the hoisting gears of cranes, more especially when these gears are remote from the controller, are pointed out by C. W. Hill in "The Electrical Review," of London.

In driving a hoisting gear, he says, we require, whether lifting or lowering, and irrespective of the actual load on the hook, to be able to run at a very slow speed for purposes of adjustment, and to be able to increase the speed to a maximum which shall vary in some inverse proportion to the load, so that light loads can be lifted more quickly than heavy ones.

With a properly-designed controller, this can to a certain extent be accomplished when lifting with a series motor. The controller can be designed to give a very slow speed on the first step regardless of the weight on the hook, and the motor, when the controller is full on, will, in a limited degree, accommodate its speed to the load. As the speed range so obtained is insufficient, it is usual to provide change gear giving either two or three speeds. The changing of these gears, especially in cases where the driver has to walk some distance or climb on to a platform to make the change, is frequently neglected, so that the change gear is of little use.

With a shunt motor, the speed can be varied instantly and without trouble, through a wide range, by means of a regulating switch and resistance connected in the magnet circuit and placed close to the driver.

The complete equipment for a shunt motor hoisting gear consists of the motor itself, a plain on and off electro-magnetic brake, a drum controller and a shunt-regulating switch placed handy. A circuit-breaker is also advisable.

With this arrangement the con-

troller is so designed that, on the first step the motor-magnet is always fully excited, irrespective of the position of the shunt regulator, so that on this step a speed as slow as desired is obtained. The controller has contacts corresponding to and connected with the contacts on the shunt-regulating switch. As it is moved over it cuts into the magnet circuit the amount of resistance determined by the position of the shunt-regulating switch, so that when the controller is full on, the speed of the motor corresponds to the position of this switch.

For lowering, the series motor is not satisfactory, as, without the assistance of a mechanical brake, it cannot prevent the load running away.

It is when lowering that the shunt motor shows specially to advantage, as, when overhauled by the load, it commences to generate current, and the current so generated not only opposes a torque to the motion of the load sufficient to keep its speed within the limit set by the regulating switch (so saving wear of brakes), but it also feeds the circuit, and so helps to drive other machines.

Electricity in Submarine Mining

THE almost indiscriminate use of mines in naval warfare, as practiced by the two beligerents in the Far East, has gone far to illustrate the practicability of modern methods of exploding them, and not the least significant fact brought to light, says "The Electrical Review," of London, is the unsuitability of electricity where it can be avoided. The chief reason for this is liability to deterioration in the Leclanche cell, which even on open circuit is apt to run down in consequence of leakage.

The cells are either made up into large batteries of about 80 cells, for use in controlling the mines from a shore station, or are placed in the mine itself, a pair to a mine; in the latter case the mines are self-contained, and are known as "electro-mechanical" mines. The circuit has only one break, known as the circuit closer, and is otherwise completed through the detonators.

The circuit closer is a form of mercury contact which acts when the mine is bumped. Now, when a mine has been laid out for some time, the interior of it, even supposing there be no leakage of water through the joints, gets very damp, the iron case sweats a good deal; there is a certain amount of leakage, therefore, across the terminals of the battery, and this is assisted by the slight creeping of sal ammoniac, which, in spite of precautions, almost invariably takes place to some extent.

This creeping may, perhaps, be in a large measure caused by the tidal and wave motion to which the mine is subjected, causing the liquid to wash about and leave deposits above its normal level; the Japanese have, it seems, rather successfully used dry cells, in spite of their liability to deterioration.

From whatever cause it may be, however, experience has shown that batteries used inside a mine deteriorate quickly, and are, therefore, unreliable after a certain length of time. Batteries used outside a mine and on a circuit to be closed by a mechanical device inside it, run down through leaks in the submarine cable. The circuit here is invariably "earthed" through the steel armouring, and so back through the sea water, and consequently the minutest leak soon develops.

It would appear, therefore, that electricity for automatic mines is doomed, and that its place will be taken by some purely mechanical device which will become released when the mine is struck, like the "horned" mines of the Russians; it is a pity that it should be so, for such mines, breaking adrift, as many have done in the China Sea, become a lasting danger to shipping until they have been destroyed.

Time Signals by Telephone in France

EXPERIMENTS were recently made by the French Bureau des Longitudes, according to "The American Telephone Journal," in sending out time signals by means of the telephone.

The work was so successful in the trials made in Paris that it was decided to extend it to the whole French telephone system. As the object is to transmit the signals with considerable exactness, a verbal signal would not answer, so a microphone was arranged whereby each beat of the pendulum of a standard clock in the observatory could be heard in the receiver. By a prearranged system of omitting a certain number of beats, or other arrangement of the signals, it is possible to identify a given signal as true noon.

The method is not only most useful for watchmakers and regulators of chronometers, nearly all of whom enjoy telephone service, but for navigators, who by simply having telephone connection either at the wharf or at an anchorage buoy can regulate their chronometers while in port by an observatory standard. This was done in the case of a French warship at Brest with an accuracy of between .1 and .2 of a second. As it is perfectly feasible to connect any telephone circuit in this way, there is no reason why the system should not be widely used.

Electrolysis with Alternating Current

IN a paper abstracted in the journal of the British Chemical Society, Carlo Rossi says that solutions of potassium chlorate acidified with sulphuric acid exhibit complicated phenomena when subjected to the action of an alternating current between copper or iron electrodes. The copper electrodes become coated with cuprous chloride, copper dissolves, and a bluish-green basic chlorate, $Cu(ClO_3)_2,3Cu(OH)_2$, separates from the solution.

When a direct current is used, cuprous chloride is formed at the anode, together with smaller quantities of basic chlorate and chloride; the solution, from which a complex mixture of cupric hydroxide, cupric oxide, copper, and cupric chloride separates out, does not contain dissolved copper. It is supposed that the copper passes into solution at the anode as cuprous ion, which reduces the chlorate, copper being then precipitated by the alkali formed at the cathode.

The non-reversibility of the change at the electrodes when alternating currents are used is probably due to the rapid removal of the cuprous ions in this manner. When, on the other hand, the potassium chlorate is replaced by sodium chloride, the alternating current dissolves very little copper. With iron electrodes similar phenomena were observed.

It is reported that artificial profiles are to be used on the new third track of the electrically-operated South Side Elevated Railway in Chicago, and also on the new Englewood extension. According to this plan, trains are accelerated and retarded by placing each station platform at the summit of a rise in the track, the grade retarding approaching trains and accelerating departing ones.

A congress of radiology and ionization will be held at the International Exhibition at Liège, Belgium, from September 12 to 14.

Electric Power from Wood Gas

By GEORGE M. DOUGLAS

A Paper Presented Before the Institute of Mining and Metallurgy, London

THE concentrating works and mine of the Moctezuma Copper Company, located at Nacozari, Sonora, Mexico, are operated by electric power distributed from a central power station.

This power house contains ten gas engines of Crossley's "Otto" type; eight are single-cylinder engines, 18½ inches in diameter by 24 inches stroke, giving 80 B. H. P. maximum, under the local conditions of an elevation above sea level of 3500 feet and the calorific value of gas supplied to them. Two are double-cylinder engines, 18½ inches in diameter by 24 inches stroke, from which 175 B. H. P. may be obtained.

These engines are belt-connected to dynamos of 65 KW. for the single-cylinder, and 150 KW. for the double-cylinder engines. They are shunt-wound machines, operated in parallel, and generate direct current at 260 volts. This is distributed direct to the mill and other motors about the concentrating plant.

The mine is 6 miles distant from the power house, and current is supplied from a motor-driven generator, giving at 6600 volts three-phase alternating current of 25 cycles. At the mine this 6600-volt current is stepped down by transformers to 230 volts. Pumps, etc., are operated from this low-tension alternating current, but for the mine hoist and electric locomotive service it is converted to 250-volt direct current by a rotary converter.

The gas is supplied to the engines from a Loomis-Pettibone gas-generating plant in which the method of operation is slightly modified from the original practice of its makers. This gas plant consists of two duplicate sets, in each of which are two generators and a boiler. A wet scrubber and exhauster, —Root's positive pressure type,—are common to both sets.

These generators are steel cylinders, fire-brick lined, of 9 feet external and 6 feet 9 inches internal diameter. The grates are about 3 feet above the bottom, and the height of the generator permits of a fire of about 8 feet in depth on the grates. The grates are made of fire-brick arches, forming a dome with 6-foot radius. There is a door on top which is used for feeding fuel and for admission of air. The generators are connected by 12-inch pipes just below these top doors and above the maximum height of fires.

Below the grates the passage of gas is through 33-inch, brick-lined pipes to a common chamber below the boiler. In these pipes are gate-valves, water-cooled externally, referred to later as *A* and *B* in referring to the annexed diagrams.

There are also three 12 by 18-inch cleaning doors in each generator,—two above the grates and on the same level, and one below, level with the bottom of generator. These are used only for cleaning ashes from the generators when they are not in operation.

The generators, boiler and scrubber are on the suction side of the Root's positive-pressure blower mentioned before. From a header on the boiler four 1½-inch pipes lead, one above the maximum height of fires, and one below the grates, on each generator. These are controlled by valves on the feed floor.

The fuel fed through the top doors forms a charge from the top of which the volatile gases are distilled. The air passes through the same door as the fuel, and partial combustion of the volatile gases and fixed carbon of fuel supplies heat to the charge. The partial combustion of hydro-carbons takes place near the top, and that of the fixed carbons lower in the charge. No unfixed gases pass through the incandescent lower part of the charge.

These gases pass through the grates of the generators up into the boiler, and thence to the bottom of the scrubber. The scrubber is a cylindrical vessel on which four or five trays filled to a depth of 2 feet with coke are placed 4 feet apart. A sprinkler is provided above the top tray, which distributes water at a rate of 3500 gallons per hour. This passes from one tray to another in an even shower, and on meeting the gases on their upward passage cleans them of fine ash and finely-divided fixed carbon.

The gases enter the scrubber at a rather lower temperature than the gases in an ordinary steam boiler uptake, and leave at about atmospheric temperature.

The water used in the scrubber may be passed over a cooling tower and used again, only deficiencies due to evaporation being supplied. If water is plentiful, a continuous stream of clean water is better. On top of the scrubber and over the sprinkler is a "header" of larger diameter than the scrubber, filled with "excelsior" wood shavings, which act as a final absorbent of soot before the gas passes to the exhauster. It may be mentioned here that the above arrangement for cleaning gas is not sufficient when using a volatile fuel such as wood or soft coal. A dry scrubber with "excelsior" or oily waste between exhauster and tank would be a decided advantage.

On the suction side of the exhauster the resistance of the charge to draught through it and the scrubber varies from 4 inches or 5 inches water pressure with new fires, to 24 inches or 28 inches with old. This depends on the kind of fuel used, amount of gas made and conditions of fires.

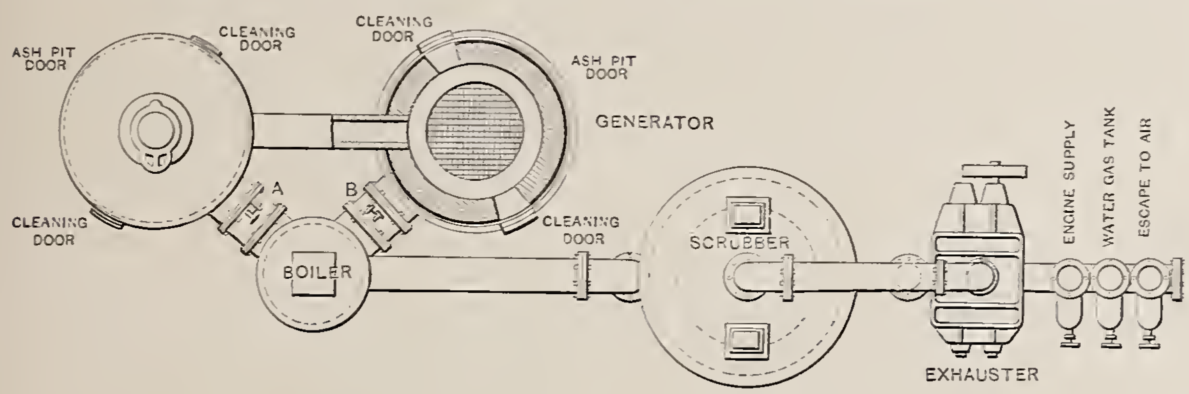
The discharge of the exhauster leads to a header from which three pipes are taken, controlled by gate valves. These lead to a large tank for engine supply, weighted to 5-inch water pressure, a small tank weighted to 8-inch water pressure, in which water-gas may be separately stored, and an open pipe to the air.

From the top of the boilers is an 8-inch pipe leading to the suction of a Sturtevant blower. This is used to supply draught when starting fires; for even where it is possible to do so it is objectionable to use the exhauster for this purpose, as in the cold fuel bed no decomposition of volatile gases takes place which would cause trouble in pipes, valves and exhauster by condensation of tar.

The wood fuel used at the Nacozari plant consists mostly of an inferior scrubby oak. A little "mesquite" is used, and another species of

oak locally called "black" oak. This latter is the best. It is supplied from neighbouring hills, and is brought to the plant in 3-foot, 6-inch lengths. These are sawed in two with a swing saw.

In starting and operating this plant with such wood for fuel, the method

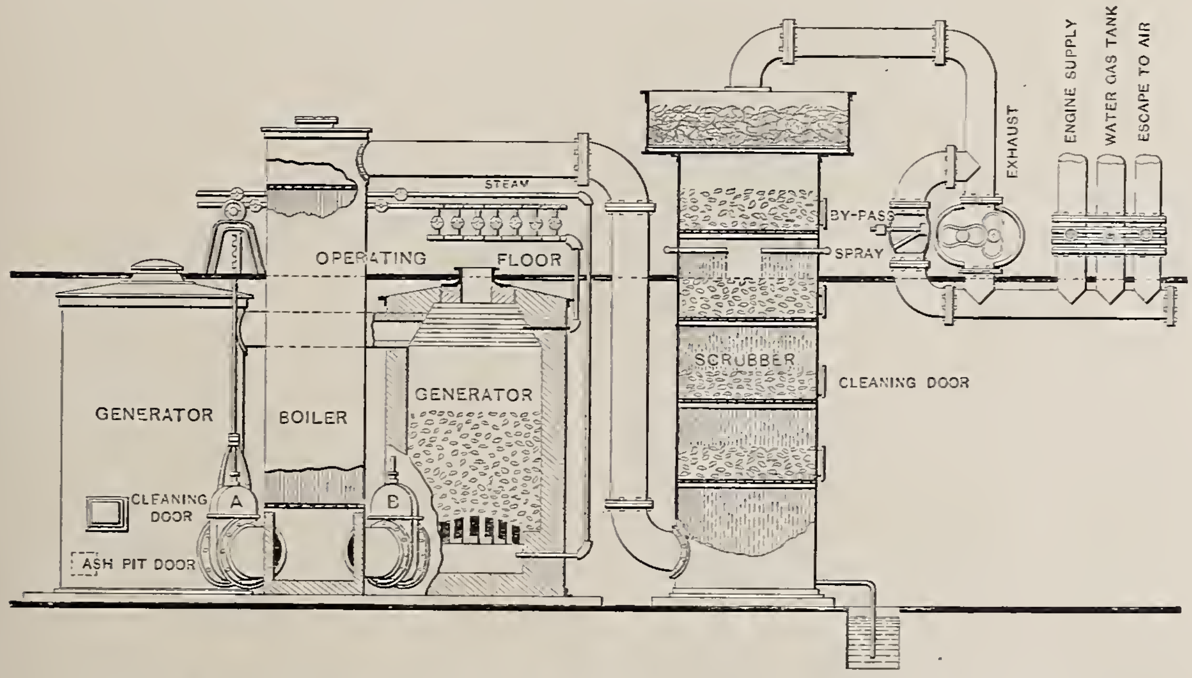


TOP VIEW OF THE NACOZARI GAS PLANT

that four years' experience has shown to be best is as follows:

Coke is put on the grates of the generators to a depth of 3 feet to $3\frac{1}{2}$ feet. Less than 3 feet is not advisable when making gas from wood, otherwise volatile products of distillation from the fuel may pass through unfixed, and by condensing to soot or tar may waste fuel and cause trouble by dirt.

The writer has had no experience



THE LOOMIS-PETTIBONE GAS GENERATING PLANT AT NACOZARI, LONGITUDINAL SECTION, INSTALLED BY THE POWER & MINING MACHINERY COMPANY, NEW YORK

with wood running high in volatile matter, such as pine, but it is probable that in the case of such woods a deeper coke bed would be preferable. Small and light wood, tops of trees, branches, etc., should be put on coke to a depth of 3 feet or so, and the blower started. A handful of lighted oily waste thrown on top of the wood will start fires. The light wood is enough to make a coke bed incandescent, and usually requires about an hour. As soon as this is seen to be the case, fast feeding with heavy wood is necessary. The heavy chunks, which are objectionable when fires become older, are well saved for this purpose. The fires should be kept at a low temperature, which may be regulated by the speed of feeding. Only enough combustion is required to transform the wood into charcoal. When a bed of this incandescent charcoal and partly-consumed wood is formed to a depth of a couple of feet above coke bed, the fires are ready for supplying gas to the engines; the valve to suction of exhauster should be opened, the fan stopped and its suction valve closed.

This preliminary operation usually requires four to five hours in time and $3\frac{1}{2}$ to 4 tons of wood.

When changing from old fires to new, as is usually the case, both main valves may be left open, so that the exhauster will act on both sets of generators. Owing to low resistance offered by new fires, only enough air will pass through the old ones to completely gasify any fuel that may be left therein. They should be stirred occasionally with a bar during this "burning down" process, and the holes filled to keep the surface level. It is easily seen when all combustible matter at top of old fires has been consumed, by the peculiar bright appearance the ashes take. The top doors should be closed at this stage and a little steam let into the generators from their top steam connections. This steam passes downward through the fires, and by its decomposition a great deal of the heat in the old fires may be utilized. As the gas from the new fires is usually somewhat poorer the first two or three hours, this "water-gas," mixing with and enriching it, can most opportunely be taken advantage of.

It is neither desirable nor necessary to make water-gas on new fires until there has been at least four hours' run on them. Water-gas is made by closing the top doors on both generators and one of the gate valves between generator *A* and boiler, and opening a valve that is in a pipe acting as by-pass from the suction to the discharge of exhauster. This is done so that no risk is incurred of throwing an undue strain on exhauster or motor by its suction being closed. The exhauster being "by-passed," the steam pressure acts directly to fill the tank. Steam is turned on below the grate of the generator, the gate valve of which (*A*) is closed. Its only passage is upward through the fire, across through the connecting pipe at top and downward through the fire in generator *B*, through boiler, scrubber, etc., to tank. After not more than two minutes of this discharge from an open pipe, $1\frac{1}{2}$ inches in diameter, steam at 120 pounds pressure the steam valve is shut, valve *A* is opened, valve *B* closed, and the operation repeated in the opposite direction, and, if anything, for less time.

In passing through the incandescent fuel, the steam is decomposed into its original constituents, hydrogen and oxygen, of which the former passes through as fixed gas, and the latter associates with the carbon of the fuel to make carbon monoxide.

The following is an average sample of this water-gas:—

H	CO	CH_4	C_nH_{2n}	CO_2	O	N
52.77	10.08	2.9	0.63	20.76	0.13	12.72

The calorific value of this at 62 degrees F. and at sea level is 240 British thermal units per cubic foot. When the plant was first started up, erroneous ideas were held, in that it was supposed a comparatively large amount of water-gas should be made and mixed with producer gas. Following this idea led to some waste of fuel and considerable unsteadiness of power.

The making of water-gas directly, as by the method described, is essen-

tial only in that it loosens up fires and ensures free passage of air and gases through them. That gas of a higher heat value is made in doing so may be considered as incidental and taken advantage of for certain purposes, such as engine igniters, assay work, etc. If the consumption of water-gas for these purposes is not sufficient to make necessary a run of about 1500 cubic feet at not greater intervals than an hour, the water-gas should be mixed with producer-gas by means of the small pipe from one tank to another, regulated to bring consumption to the desired amount. Making long runs of steam through the fires, alternating with periods of violent blasing, means uneconomical use of fuel and unsteady gas. Too much stress cannot be laid on the desirability of keeping the fires at as even a temperature as possible.

When using coal for fuel, the heat of fires and gas values may be regulated to a nicety by constant admission of steam through the top connections to mix with air before passing through the fuel bed.

With wood for fuel, there is enough moisture present in the fuel itself to supply this steam for decomposition. When making gas at the rate of 1100 cubic feet per minute from 6 feet to 9 feet in generators, experience shows best results are obtained from wood containing 12 to 14 per cent. moisture. At this rate of gasification, and from generators of this internal diameter, good results cannot be obtained if moisture in wood exceeds 20 per cent. At a higher rate of speed, or with generators of smaller diameter, it would be found that fairly good results would be obtained with wood containing even more than 20 per cent. water.

The dryest and best seasoned wood at Nacozari contains not less than 8 per cent. moisture, and it is found that better results are obtained from wood containing a slightly greater amount of water. This may be due to the fuel value of the wood deteriorating during the long exposure necessary to reduce moisture to a small amount.

Burning wood at the rate of 30,000 pounds per diem, the ash accumulates, so that by the fifth day's run on one set of plant it is necessary to shut them down to clean, changing to other set as described, for operation.

For the first 36 hours the fires should be allowed to rise, i. e., more wood should be put in than is consumed to ash. This becomes charcoal and adds steadiness to the value of the gas. There is no ultimate loss, all fuel in generations being recovered before shutting down to clean.

The wood should not be longer than 2 feet; heavy chunks are objectionable and should be split; the size of the wood is a point to which attention must be paid, since using large and irregular-sized wood produces poor results. The heavy chunks that cannot be split easily should be reserved for starting fires, and may be used to good advantage during the first 12 hours of the run. The fire should be fed steadily and a little all the time. Judicious use of different sizes of wood must be made by attendants to keep the surface of the fires level and ensure even passage of gases through them. The manual dexterity to place a stick of wood where it is at best advantage is an important thing to be acquired by the attendant.

This statement may be decried by some as trivial, but it will be found that success depends on the amount of attention paid to these trivialities. Bars or pokers should be used as little as possible except during the first six or eight hours on new fires, when the wood must be kept well raked out to the sides from the center of fires. During the first 24 hours great care must be taken by the attendants to ensure the fires being evenly built up. The effect of carelessness then will be felt throughout the run. Though the operations are extremely simple, and any intelligent fireman can soon handle the plant, there, nevertheless, exist opportunities for wasting fuel and causing irregularities in the power that are not present in a steam boiler plant. Its economy and satisfactory operation being thus dependent to a large extent on the skill and attentiveness of firemen, it is imperative that right methods be systematically observed.

The following is a sample that may be taken as an average of the composition and calorific value of this wood-gas. It is the average of more than 15 tests taken at various times:—

H	CO	CH_4	C_nH_{2n}	CO_2	O	N
19.5	13.45	2.48	.34	15.45	.25	48.5

The calorific value in B. T. U. is 135.6 at 62 degrees F., and sea level.

The above gas gives remarkably good results in the engines, and is better than gas from coal of the same calorific value, but in which the proportions of hydrogen and carbon monoxide are reversed. The writer can offer no reason why such should be the case, but it is demonstrated by practical experience. That hydrogen is a quicker burning gas than carbon monoxide may have something to do with it. The proportions of CO_2 and N are about 8 and 55 in coal gas, compared to about 15 and 48, respectively, in wood gas, which may have some effect on the charge, although they are both inert gases.

No trouble is experienced with pre-ignition, though the percentage of hydrogen in wood gas occasionally runs up to 23 per cent., and the compression of engines is as high as 90 pounds, with pistons uncooled by water.

As all output is measured through one integrating wattmeter, and all fuel used to pass over scales before entering the feed floor, the figures from the Nacozari power plant offer exceptional accuracy.

A trial was made recently on one set of generators for a run in which the greatest care was taken to ensure accurate figures. There was no intention to make an exceptional showing; indeed, the conditions of fuel as regards moisture, and the fact that the output was only about two-thirds capacity, made the best showing out of the question. The transmission line was not in operation during this trial.

Fires were lighted in the set of generators, and the trial was made at 9.30 A. M. on December 26, 1904. At 3 P. M. they were ready to run on, and the old fires were discontinued altogether at 7 P. M.

At 2 P. M., December 31, after 4 days, 23 hours' run, a change was made again and the trial completed.

The following is the output and fuel consumption:—

Coke put in generators................8,590 pounds
Wood used firing up...................7,400 pounds
Duration of run...........................119 hours
Total amount of ash taken from generators,
14.124 pounds
Amount of coke recovered.............2,572 pounds
Total amount of wood used.........138 840 pounds
Total amount of coke used...........5 918 pounds
Total amount of combustible........144.758 pounds
Percentage of water in wood.........19 8 per cent.
Percentage of ash in wood...........10.3 per cent.
Calorific value of gas B. T. U. (actual)
(average of 35 tests made throughout
trial) 116.4

Total output of power house =
39,700 K. W. hours
53.217 H. P. hours

Average power = 447.2 electric H. P.

Consumption per electric H. P. hour =
2.6 pounds wood
0.11 pounds coke

A brief summary of the advantages or faults of the gas producer and gas-engine plant may not be out of place here. A general statement as to whether this form of power production is advantageous or not cannot be made; it depends on the purposes for which power is required, amount of power required, particulars as to service, environment of plant, price of fuel, of labour, quantity of water obtainable,

and pecuniary circumstances of the investor.

Speaking roughly, the great advantage of the gas-engine plant lies in its extreme economy of fuel; in nearly every other respect it is at a disadvantage compared with steam. Its first cost is greater; time required for installation is longer; in operation it is more expensive, and, except in generation of electricity, it is more difficult of application than the steam engine. In the operation of the engines the skilled labour necessary is not so easily acquired, though manufacturers are emphatic in assuring would-be purchasers that "anyone can handle a gas engine;" in reality it requires closer attention than a steam engine, especially when running several engines in parallel and using producer gas.

And the reason for this is not far to seek. In operating a steam engine, the attendant has but to "turn the power on" in the cylinder, open the main stop-valves, and keep steam at the required pressure in the boilers; if the results are not as they should be, the fault lies in the "brains" of the plant. And, indeed, a steam engine may suffer a great amount of abuse and still do faithful work. But in the case of the gas engine, the attendant must make the power in the cylinder, the mixture of gas and air must be adjusted to give best results, and igniters must be kept in good condition. If the gas engine is abused, it will give but a very low percentage of its power, or even refuse to work at all; hence the necessity for an alert attendant and an ample power margin. For a thoroughly reliable service, it is safe to take manufacturers' ratings at 75 per cent. of their value; it will surely be found to pay in the long run.

The above remarks concerning operation of engines are not intended to apply to gas engines of small power running on city gas.

As far as the water is concerned, the gas plant shows an advantage in this respect over a steam plant of equal power. But it is not pronounced. The fuel economy is thoroughly to be relied upon. At Nacozari the average is about 2.5 pounds of wood per B. H. P. hour, and 1.3 pounds of coal.

Christchurch, New Zealand, will have an international exhibition next year, to extend from November, 1906, to April, 1907. Prospective exhibitors can get further information about it from the Secretary of the Local Committee of the New Zealand International Exhibition, at Christchurch.

The Havana Central Railway System

THE Havana Central Railway Company, of Havana, Cuba, has placed orders with the foreign department of the General Electric Company, of Schenectady, N. Y., for the complete electrical equipment of a network of interurban electric railway lines radiating from Havana and covering an extensive territory inland.

The system will consist of a central power house at Havana and eight outside sub-stations, together with line material for about 125 miles of trackage and rolling stock for passenger and freight service over the entire system.

The power house at Havana will furnish 5000 KW. of 19,000-volt, 25-cycle, three-phase alternating current, which is to be generated by two 2000-KW. 2200-volt generators driven by Curtis steam turbines. The 2200 volts will be stepped up through air-blast transformers to line voltage. The transmission lines will parallel the various lines of the railway to the sub-stations, where step-down transformers will supply low voltage to rotary converters furnishing 600-volt direct current to trolley lines and feeders.

From Havana one branch will run southeast through Cuatro Caminos, Lomas de Candela, Guines, Providencia to Rosario, a distance of about 40 miles. Sub-stations will be located at Cuatro Caminos, Lomas de Candela and Providencia. A second line will run from Havana 17 miles south to Bejucal, with a sub-station on the line at Santiago de las Vegas. The third line, running southwest from Havana, will have a length of 37 miles, and branch lines running north and south of El Carmelo, Santiago de las Vegas and Tuira de Melena, amounting to about 30 miles in addition. Sub-stations on the line to Mariel will be placed at Marianao, Hoyo Colorado and Guanajay, and at San Antonio Melena.

The rolling stock for passenger service will consist of 24 30-ton cars seating 50 passengers and equipped with four GE-74 motors geared for a maximum speed of 40 miles per hour. The freight service will be handled by 10 40-ton General Electric locomotives equipped with four GE-55 motors geared for a speed of 17 miles per hour when hauling a 300-ton train.

The entire system will have a double overhead trolley, both in Havana and on the interurban lines. The high-potential transmission lines will be designed for a future potential of 30,000 volts to provide for extensions. The transformers in the Havana power house and in the sub-stations are also suitable for use on the increased potential. It is expected that the entire system will be in operation inside of 18 months, and that portions of it will be giving service before that time.

Wireless Telegraphy for Railway Trains

TESTS of wireless telegraphy for railway trains were recently conducted by the American De Forest Wireless Telegraph Company, of St. Louis, at the instance of President Felton, of the Chicago & Alton Railway. Messages were clearly received upon the Alton limited train up to distances of 35 miles from the transmitting stations, although these were in no case located near the railway tracks, and were not destined for this particular work. Messages were received with surprising persistence when the railroad yards of Chicago were completely hidden in cuts and blanketed by gigantic elevators, gasometers and steel structures of every description.

In the Alton "Red Limited," which leaves St. Louis before the opening of the stock market, bulletins will be posted in the cars giving the turns of the market and other interesting news. Orders to train crews and messages to passengers will also be transmitted by wireless telegraphy. Another application of wireless telegraphy on railway trains will be its use as a safety device whereby each train or locomotive will carry with it a warning zone of influence extending from 1 to 2 miles in either direction. In any locomotive equipped with a wireless receiver, coming within this zone of influence, a warning bell can be rung indicating to the engineer that he is within this distance of some other train. For this latter purpose, of course, no operator is required on board the train, and the arrangement is such that if for any reason the automatic transmitter in the cab of a locomotive gets out of order, a danger signal is set, which at once apprises the engineer of that fact. In the same way, if the receiving warning signal becomes inoperative, the engineer will be at once notified.

If you get a result without strenuous effort, says Thomas A. Edison, there is only one rule, and that is, to begin all over again, for you are on the wrong path.

THE ELECTRICAL AGE

Volume XXXV Number 2
$2.50 a year; 25 cents a copy

New York, August, 1905

The Electrical Age Co.
New York and London

ESTABLISHED 1883

Published monthly at 3, 5 and 7 W. 29th Street, New York City.
Telephone No. 1617 and 1618 Madison Square. Private branch exchange connecting all departments. Cable Address—Revolvable, New York.

SUBSCRIPTION RATES

The Electrical Age will be sent post free anywhere in the United States and its possessions, Canada and Mexico for $2.50 per year, single copies 25 cents. To Great Britain and all countries embraced in the postal union, $5.00, 20 shillings, 25 francs, 20 marks, or 15 rupees. Send subscriptions to our nearest branch office or agency.

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Insertion of new advertisements or changes of copy cannot be guaranteed for the following issue if received later than the 15th of each month.

LONDON OFFICES

Business Department, 33, Bedford Street. Editorial Department, 22, Henrietta Street. Covent Garden, Strand, W. C.

London Telephone, Post Office, 3807 Central. Private branch exchange. London Cable Address—Revolvable, London.
All remittances to London Office should be crossed London and County Banking Company.

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Leading Articles

Electricity at the Peace Conference

ONE of the most interesting features of the Russo-Japanese war has been the extensive use of electricity in both offensive and defensive operations. From the firing of mines and other explosives at a distance, to the use of the searchlight in repelling assaults, and the telephone on the firing line, numerous applications of electricity have been important auxiliaries in the success or failure of the various campaigns. Wireless telegraphy was of immense value to Admiral Togo on the morning of May 27, when the ill-fated fleet of Admiral Rojestvensky appeared on the horizon of Tshushima Strait. It has remained for the Peace Conference, however, to demonstrate the usefulness of electricity in furthering deliberations that may bring hostilities to a close.

Realizing that the eyes of the entire civilized world would be focussed upon Portsmouth, N. H., during the sessions of the Russian and Japanese envoys, the telegraph and telephone companies provided extraordinary facilities for the handling of the anticipated traffic. The Postal and Western Union Companies each ran two special circuits from the Navy Yard to their city offices, and also established auxiliary offices at the Hotel Wentworth, where the envoys' quarters were located. Two temporary aerial cables aggregating forty-one wires were installed between the offices and the hotel, a distance of $3\frac{1}{2}$ miles, while eight quadruplex, six duplex and twenty-one single-loop circuits were connected up for service. Provision was made for a maximum of fifty operators at the Wentworth, and sixty-five operators at Portsmouth, in case of need. It was planned to send the Russian messages to St. Petersburg via the Canso cable station, and thence across the Atlantic to Ireland or England, while the Japanese despatches traversed the land lines of the Postal or Western Union Companies to San Francisco, and thence passed to Tokio via the Pacific cable and Hong Kong.

The telephone company anticipated an irregular increase in its toll traffic between Portsmouth and New York, Washington, etc., and it doubled its facilities in the way of trunk lines to Boston. Special telegraph and telephone service was also installed in the private apartments of the envoys.

The importance of the plenipotentiaries being thus able to keep in touch with their respective sovereigns is highly significant, and, although the outcome of the negotiations is unsettled at this writing, it is certain that the facilities offered may be productive of the greatest good through the prompt settlement of doubtful points which they make possible. The small army of newspaper correspondents present at Portsmouth could do little satisfactory work without the extra telegraph and cable service provided. Certainly no ordinary interest is attached to the concentration of such facilities upon an event of so great historic import, and the promptness and completeness of the companies' preparations is characteristic of American business methods.

Electric Train Lighting

THE evolution of electric train lighting equipment has for several years past been a matter of increasing interest in engineering and transportation circles, and at the recent exhibition of railway appliances at Washington, several notable displays were made in the way of rolling stock illumination. It is evident that the requirements of the train lighting problem are better appreciated to-day than ever before, for most of the apparatus now upon the market is rugged in design, well put together mechanically, and simpler in its operation than the earlier equipment placed in service.

Among all the appointments of luxurious railway travel, the car lighting arrangements stand in the front rank of importance. A poorly lighted car is always a source of annoyance and complaint, and is never excused by the traveling public even though elaborate facilities in other directions are provided. There can be no question as to the superiority of electricity over the use of either gas or oil. From the sanitary stand-

point the use of any illuminant which consumes the oxygen of the air is undesirable; the menace from tanks of highly compressed gas carried under the floor of the car; the unpleasant odour and danger from fire in case of accident; and the lack of flexibility encountered, all are serious disadvantages which are entirely absent in the use of electricity. Everyone knows the admirable distribution of incandescent lamps common on electrically-lighted trains; from the convenient berth light in the sleeper to the decorative bulb on the dining-car table, flexibility is the striking feature, supplemented by perfect cleanliness and safety.

The nature of gas precludes the possibility of reading fine print in comfort in every part of a car, and the unavoidable assembling of clusters of oil lamps or gas jets in the car roof naturally means a poor distribution of light. The adoption of electric car lighting equipment opens the way to the use of fan motors in warm weather, electric curling iron heaters or other warming devices, illuminated signs or transparencies at the rear end of the train, and vestibule step-lamps which automatically start burning when the car stops and extinguish themselves when the train attains headway.

Of the two general methods of electric train lighting now advocated, each has certain peculiar advantages. Probably the simplest scheme is that in which a small direct-current generating set, in the baggage car, supplies current to the train through suitable cable couplings, steam being drawn from the locomotive boiler. A 15-KW. turbo-generator for this purpose was shown at Washington, the speed of the set being 4000 revolutions per minute, and the floor space only 22 by 66 inches. The operating potential was 80 volts—a decided advantage in the matter of wiring. The difficulty with this arrangement occurs when the locomotive or any of the cars are disconnected from the train; hence the low first cost is to some degree offset by the lack of flexibility of the system; while if one goes to the extent of placing a storage battery on each car it is about the same problem as equipping each car complete.

The majority of train lighting systems now exploited fall under the class in which each car is fitted with its own complete outfit, and the usual plan is to drive a small generator either by belting or direct connection from the car axle, supplying the lighting circuits from this machine at speeds of 15 miles per hour and upwards, and falling back upon a storage battery when the speed slackens, or the car is at a standstill. The key to success in this problem is the automatic controlling mechanism, and it is gratifying to note that apparatus is now in service which transfers the load from dynamo to battery and vice-versa without the slightest perceptible flickering of the lamps.

With such self-contained equipment every car is independent of its surroundings; the entire system is automatic; there is nothing added to the duties of the train crew beyond the turning on or off of an ordinary switch; there is no danger from fire or explosion, and in the event of a car being side-tracked or stopped, as in a snow storm, the lights may be supplied from the battery for, say, four nights, by reducing to one-quarter of the full number, which is longer than provision is made by any other method for the illumination of blocked trains. Provision is made for the maintenance of constant voltage at the lamps throughout the entire speed range and forward or backward motion of the train.

Several important points should be borne in mind in selecting train lighting equipment. Simplicity in design and operation are constantly to be sought; inspection should be easily made; the mechanism should be rugged in construction and positive in action, and it should be impossible for the equipment to be put out of business by sand, snow, ice, water, escaping steam or tilted trucks. The parts should all be made to gauge, easily replaced and interchangeable, and the regulation of the current supply should be smooth, with uniform voltage. Although the first cost of such an equipment may be upwards of $1500 per car, the expense of operation and maintenance ought to be lower on the basis of cost per car per annum than with any other system of car lighting. From fifty to seventy-five 8-candle-power lights are commonly installed, and it should be an easy matter to make complete service tests before awarding a large contract covering many equipments.

Useful as electric train lighting is in Pullman and day coach service, its benefits are nowhere more keenly appreciated than in mail cars. A large part of the sorting and distributing of mail is carried on at night, and only those who have seen railway postal clerks at work realize the importance of a well-lighted car to facilitate their duties. The elimination of vitiating heat, reduction of fire risk, and properly distributed illumination obtained by electricity are important elements in the betterment of working conditions in the railway mail service. In view of the fact that less than 3 per cent. of the steam railway passenger cars in this country are electrically lighted, it is evident that the future holds great opportunities in store for the progressive manufacturer of train-lighting equipment. The day will come when all important trains will be lighted by electricity.

Manganese Steel in Trackwork

THE peculiar physical properties of manganese steel have for some years past been familiar to specialists in metallurgy, but it is only recently that steam and electric railway engineers have begun to realize the possibilities of this remarkable alloy when used in regular and special track-work. At two recent meetings of the New England Street Railway Club, the papers presented summarized both the general characteristics of the metal and its behaviour in specific installations under severe operating conditions.

In exact reverse to the action of the usual hard steels, an alloy of manganese and steel containing over 6 per cent. and not over 20 per cent. of manganese, while already hard, becomes more ductile and tougher when heated to a high temperature and suddenly cooled by plunging into water, without losing its inherent hardness. This property, accompanied by long study of the treatment and testing of the exact proportions best adapted to different uses, such as burglar-proof safes, stone-crusher jaws, screens for coal mines, dredger pins, etc., enables the metal to be worked into rails, frogs, crossings and switch points with full expectation that its prodigious wearing qualities will insure long life. Two cases drawn from recent practice illustrate how well these expectations have been fulfilled.

A manganese steel frog placed in the tracks of the Pennsylvania Railroad at Philadelphia in 1900 remained in service four years and forty-seven days at a point in which the maximum life of an ordinary steel rail frog was not over three months. The frog was then worn down at the point about 5-16 inch, the rails at the ends being badly used up. The frog was sent to the shop; new rails were fitted into the ends, the central part being bent up in a hydraulic press to the extent of the vertical wear, and the entire surface was ground level at a moderate cost. The frog was then as good as new. It was placed again in service at the same point, and is still doing duty. Over 3000

manganese steel frogs are now in use upon steam railways in addition to a large number of crossings. Guard rails of this material are also in use in steam railway track, and tests are being made with split switches having manganese steel point rails.

Probably the most striking success obtained with manganese steel rails thus far in the sphere of electric railroading is that enjoyed by the Boston Elevated Railway Company upon the sharp curves of its elevated division. On this system there are eighteen curves of less than 100 feet radius, and sixteen others less than 150 feet. The total average daily car mileage is 20,000; the length of main line and secondary track is a little over 13 miles.

In making a round trip upon the elevated division, about 10.07 miles, a train makes the equivalent of 9.43 complete circles. The sharpest curve has a radius of 82 feet. Upon this curve ordinary commercial rails lasted on an average just 44 days, and measurements showed a top wear of from 0.05 to 0.064 foot in that time. A manganese steel rail was placed in the track on this curve in April, 1902, and it is still there. It has already outlasted about twenty-five ordinary rails with but one-third the wear. Although manganese steel rails will stand rolling friction indefinitely, they will not bear up as well under the grinding friction of the wheel flanges, so that a greased guard rail is now used in Boston to protect the manganese rail from this side wear.

Some of the Boston rails were subjected to very severe tests before being placed in service. They were turned out in 20-foot sections. One rail was bent cold to 20 feet radius; half of this rail was then straightened out again and curved the reverse way to 20 feet radius; and finally the other half was curved down to a radius of but 10 feet. With all this bending there was not the least sign of fracture.

The great disadvantage of manganese steel for general use is its hardness. Valuable as this property is in connection with the wear of special track-work and curves, it is difficult to handle in the foundry; its shrinkage is enormous, about 7 inches in 20 feet in the manufacture of the Boston rails mentioned; it cannot be drilled or machined, and all finishing has to be done by grinding with emery wheels. The production of complicated castings is a serious matter. For use in hard-center special track-work and in rails subjected to extraordinary wear it apparently has no equal, judged by the light of present experience. It is probably too expensive a rail for use in straight, simple tracks, although in cases like that of the Boston elevated it is cheaper in the end than an ordinary rail. The choice of manganese or ordinary steel rails for any given installation is a typical engineering problem, depending upon accurate knowledge of track depreciation and relative costs for its solution. It will be interesting to analyze the operating data which the near future should yield in regard to the behaviour of manganese steel in track-work.

High-Frequency Electric Treatment

THE recent death of a woman while undergoing "high-frequency" electrical treatment in London has raised the question as to whether it is advisable to employ such currents so indiscriminately as now appears to be the practice on the assumption that, owing to the low strength of such currents, they are practically harmless. In the case in point, the patient had, for some time previously, been taking a "light" bath treatment without any apparent benefit. High-frequency treatment was then resorted to, seemingly with favourable results, until one day, after less than one minute's application of the current, alarming symptoms manifested themselves, and the woman died in a short time. An autopsy revealed that death was due to cerebral hemorrhage, but whether this was the result of natural causes, or was superinduced by the high-frequency current, is not known.

It is, however, known by numerous experiments with the sphygmograph that important changes in blood pressure occur when high-frequency currents are passed through the human body, and it is quite within the possibilities that in the case of weakened membranes, an increased blood pressure might produce unfavourable results.

No doubt there is yet much to be learned concerning the effect of high-frequency and of other electrical currents upon the human organization. From certain unfavourable results that have, within our own knowledge, followed high-frequency and spark treatment by careful physicians, we are led to the view that possibly some individuals are unfavourably idiosyncratic to general electrical treatment,—a condition which is not readily susceptible of demonstration beforehand. In the face of this possibility, and the occurrence of such accidents—coincidences, perhaps—as that to which we have referred, it would seem at least the part of prudence that medical practitioners should proceed with extreme caution in the application of high-frequency currents and the static spark treatment, especially in the case of aged and enfeebled patients. We are aware that certain prominent electro-therapeutists would dismiss such suggestions with the statement that accidents occur on sea and land, and yet we travel. That is true, but it is no argument against taking every honourable safeguard to prevent such accidents.

Apropos of this general subject, it may be remarked that in addition to the possession of a thorough knowledge of the effect of electricity upon the human system, there is unquestionably much need also of a more extensive knowledge of electrical laws on the part of physicians who employ electricity in their practice, in order that they may apply it with proper intelligence and effect. As an instance, it may be noted that for years physicians have been using what they term high-frequency, oscillatory currents, derived from condensers charged by static electric machines, for the treatment of disease, and have been in the habit of attributing the favourable results obtained to the oscillatory character of the current. In point of fact, as certain calculations by electrical engineers have recently demonstrated, the resistance of the oscillatory circuit, which usually includes the patient, is ordinarily too great to permit such oscillatory currents, and, in consequence, instead of oscillatory currents, pulsatory unidirectional currents of high frequency result. While the name by which the current is known does not in itself affect the therapeutic result, yet it is, as we have intimated, obviously very desirable that the physician should possess a fairly accurate knowledge of the nature of the current that he employs.

Picturesque Electric Searchlight Uses

AMONG the many instances in which electricity is utilized in producing pleasurable scenic effects, certainly not the least is that in which the electric searchlight is employed on steamboat lines in lighting up the surface of the waters and the shores along the routes frequented by tourists in different parts of the world for the entertainment of passengers.

By reason of the long range of

palisades and mountains through which the Hudson River passes between New York and Albany, it is particularly well adapted for displays of this kind, and on the People's Line of steamboats that ply between those points these scenic effects are now regarded as one of the chief attractions of the trip.

On moonless nights, prior to the introduction of this source of entertainment, the outer decks of these floating palaces were given up almost exclusively to the sentimentally inclined, while the majority of the passengers remained in the brilliantly-lighted parlors, passing the time away until the hour for retiring.

Now, the sentimental traveler and the ordinary traveler alike are attracted to the outer and upper decks, where they remain until near midnight, watching with the keenest interest the kaleidoscopic pictures that the searchlight is constantly unfolding to their view, first on one bank of the river, and then on the other. Now it is a near-by yacht resting quietly at anchor; next it is a lighthouse that stands out clearly defined amidst the surrounding darkness. Anon, it is one of the numerous mansions—castles they would be called on the Rhine—that adorn the landscape. Again, it is a patch of cliff, on the brow of which, as if by prearrangement, stands a party of six or seven people waving handkerchiefs and lanterns that have lighted their path to this seemingly perilous spot.

The searchlight is also frequently turned on the trains that go rumbling by on both shores of the river. It is noticeable, however, that for obvious reasons the careful operators of the searchlight on the boats never flash the light on the engine or in advance of the engine.

One of the most striking features of these fleeting pictures is the remarkable manner in which the searchlight brings out the colours of the objects thus held up to view. Every natural day-light colour appears to be intensified and beautified; even the light of oil lamps and lanterns standing out as clearly as an artist might, or at least would endeavour to, depict them in a painting.

In a total production of 632,166 tons of copper for 1904, the United States was represented by 55 per cent., or 349,866 tons. During the year seventeen copper companies declared dividends aggregating $26,160,000. About two-thirds of the American production is exported, practically all going to Europe.

Book News

Electrician's Handy Book

By T. O'Conor Sloane, A. M., E. M., Ph.D. Size 4½ x 6½ inches. 800 pages. 500 illustrations. Published by the Norman W. Henley Publishing Company. Price, $3.50.

This work is a useful compilation of many items of information relating to electrical and magnetic laws, systems and apparatus. It differs materially from the ordinary electrical engineers' pocket-book in its treatment of electrical subjects, and may therefore be said to be entitled to a place in the electrical engineer's library among his other works of reference.

There are forty-one chapters in the book, each devoted to specific subjects, ranging from mathematics, electric quantity and current, Ohm's law, magnets, direct-current generators and motors, to transformers, station notes, switchboards, electroplating, telegraphy, telephony, bell wiring and electric heating. This will give a fair general idea of the scope of the book. The type of the text is clear, and the illustrations are generally well designed and executed.

American Telephone Practice

By Kempster B. Miller. Size 7 x 10 inches; 904 pages. Published by the McGraw Publishing Company. Price, $4.

The electrical industries form a most interesting quartet. Saving the telegraph, a generation ago not a dollar was invested in an electrical art. To-day in the United States alone the electric railway has absorbed $2,300,000,000; lighting and power, $700,000,000; the telephone, $500,000,000, and the telegraph, $200,000,000.

Of this curious plutocracy the telephone is the most unique member. Its birthplace was the Philadelphia Centennial, the date, 1876; so that it has not attained its thirtieth year; yet withal, at half the age, it is commercially twice as powerful as its telegraphic rival.

For the first two-thirds of its life telephony was the exponent of monopoly in the extreme. Court after court construed its patents to cover the transmission of speech by undulatory electrical currents. There is yet no other conceivable means. The fundamental patents were held by a company that reserved to itself exclusively the manufacture of all telephonic apparatus; to its affiliated organization the sole right to conduct a telephone business, and relegated to its archives all recorded knowledge of telephony as an art.

A decade ago there were 300,000 telephones in use in the United States, but it is said that only one man in the world knew the secret of the granular carbon of the microphone. Switchboards costing hundreds of thousands of dollars were in operation, yet one could search libraries in vain for an American description of their construction. In Great Britain a little book by Sir William Preece gave the principal account of the multiple board; but in Germany and France the paucity of telephonic literature was almost equal to that in the United States. Partly by monopolistic control, partly by reason of extraordinary business ability and sagacity, but chiefly because of the unusual demand for telephonic service, the success of the Bell Company had been almost proverbial, and the inventors only awaited the expiration of the fundamental patents to attack so shining a mark. So, in 1895, the independent interests were forming for that battle royal that has since been unceasingly waged.

But, alas! it was a case of the blind leading the blind. No one outside of the Bell interests knew anythink about telephony; there were no books; even the Patent Office records buried inventions in masses of verbiage that did not disclose their purpose, and it was a penal offense to be caught dissecting apparatus that was merely rented. Mr. Miller was the first to rend the veil. In the latter part of the nineties the first edition of "American Telephone Practice" made its appearance, the earliest and by far the most complete account of telephony as a whole in any language.

Since the first edition was issued, telephony has progressed by leaps and bounds. There are twenty times as many telephones to-day as there were in 1895. The common battery switchboard has relegated the magneto to the scrap heap; the conduit has displaced the pole line, the aerial cable the open wire, and Mr. Miller, with another decade of experience as superintendent of one of the best of independent manufactories, has revised and modernized "American Telephone Practice" in this, the fourth edition.

Naturally, the author commences with an historic account of the magneto telephone and the battery transmitter. This is followed by a few pages on induction and capacity. Possibly these introductory pages are necessary, although as history or instruction in the fundamental principles of electricity the matter is too meagre to be interesting to the stu-

dent, and too trite to attract others. In Chapters IV., V. and VI. the author discusses modern telephone receivers, the carbon battery transmitter and induction coils; and here he begins to display the strength of the expert in a clean-cut account of the fundamental apparatus of the telephone system.

Chapter VII. is a somewhat perfunctory account of primary batteries. Chapters VIII. and IX. deal with local battery sub-stations, whose various forms are fully illustrated. In Chapters X. and XI. the author for a moment drops telephonic apparatus and briefly considers some of the properties of telephone lines.

"The Magneto Switchboard for Small Exchanges," "Theory of the Multiple Switchboard," and "Transfer Systems" form the titles of Chapters XII., XIII. and XIV. These sections show the prevailing types of apparatus which are employed, illustrate the methods of assemblage, and describe the difference in handling business upon multiple and non-multiple switchboards, but the author very carefully avoids stepping upon that debatable ground, the multiple versus the divided switchboard.

The discussion of the common battery is presented under the captions of "Signaling in Common Battery Systems," "Common Battery Switchboards for Small Exchanges," "Common Battery Sub-Station Equipment," "The Common Battery Multiple Switchboard," "Trunking Systems," "The Divided Multiple," "Private Branch Exchanges," "Party Line Systems," "Measured Service," and "Toll Switchboards." Here the author displays his real strength and presents the telephonic public with information which has long been desired.

Technically speaking, a circuit is that concatenation of apparatus whereby telephonic business is transacted. The common battery switchboard has opened the widest of fields in which the telephonic inventor may disport himself, and of this opportunity electricians, both Bell and independent, have right royally availed themselves. As a result, scarcely has a switchboard been installed, but a better or a cheaper one has clamoured for recognition. Each manufacturer has pet circuits of his own, which are difficult of comprehension without a special education. Mr. Miller has collected and presented to the public the first accurate, comprehensive and lucid digest of the common battery circuits of the day, for which telephonic electricians will ever owe him a considerable debt.

Chapter XXVII. exhibits details of common battery switchboard apparatus. Chapter XXVIII. to XXXIII., inclusive, are occupied with power plants, including storage battery distributing frames, protective devices and wire chief's equipment.

Under the heading of the "Layout and Wiring of Central Office Equipments," the general design of a modern telephone exchange is somewhat cursorily described, the chapter appearing as an after-thought, much of its matter properly belonging under previous headings. Chapter XXXV. takes up automatic switchboards. The closing pages of this are taken from the author's paper on the same subject before the St. Louis Electrical Congress last year. Certainly all good telephonists trust Mr. Miller may be able to enter that promised land of operatorless exchange which he so ardently and glowingly describes. "Intercommunicating Systems" occupy Chapter XXXVI., and in Chapter XXXVII. the hypothetical telephonical relay, for whose successful invention a million-dollar prize has been offered, is "rechauffé" for the reader's delectation.

In the concluding chapters—XXXVIII. to LII., inclusive,—it deals chiefly with line construction and testing. Considering their importance, the conduit and the aerial cable are dismissed with somewhat scant treatment. In fact, this part of the volume so strongly savours of the earlier editions, that the reader will feel that Mr. Miller's duties as an inventor have left him too little time to keep himself "au courant" with the improvements in this particular direction.

Although "American Telephone Practice" is pre-eminently descriptive of apparatus rather than of operating, it is the most complete and well written of any volume of its kind, and will be warmly appreciated by thousands of workers in the telephonic field who, by bitter experience, know how difficult it is to obtain accurate technical information of the art that they follow.

It is impossible to commend too highly the care with which the circuit diagrams have been wrought, although unfortunately photographic reproduction has rendered the reference letters sometimes illegible. Copious use has been made of halftones intrinsically beautiful, and had the press work been equally good the volume would have been a magnificent specimen of book-making.

An electrical exhibition is to be held at Kiev, Russia, in the spring of 1906.

Improper Use of Incandescent Lamps in Coal Mines

EXPERIMENTS by M. F. Holliday in a British coal mine to determine the extent to which fires may be caused by the injudicious placing of incandescent lamps have shown that a 100-volt, 16-candle-power lamp is capable of causing smoke to rise within three minutes when embedded in coal dust, or may cause flame within 25 minutes when laid on the top of coal dust.

The investigations recently conducted by a British inspector of coal and metalliferous mines, also proved that when a 16-candle-power lamp was placed upon and partly covered by coal dust an explosion of the bulb occurred at the temperature of 450 degrees F. within four minutes. These experiments further showed that when the heat had increased to a certain point spontaneous combustion began, and the temperature continued to rise until the coal caught fire, although the lamp had been removed for some time.

Water Required for Gas Engines

ACCORDING to the "Engineer," the quantity of water required at the ordinary temperature of 60 degrees F. inlet, and 150 degrees outlet, to keep the cylinders of gas engines cool is 4.5 to 5 gallons per indicated H. P.-hour. The jacket pipe should be from 1 to 2 inches diameter for engines up to 20 H. P., while for larger engines the sizes are generally 2 to 3 inches for the inlet and 2.5 to 3.5 inches for the outlet. Tanks for circulating the water are generally made with a capacity for furnishing 20 to 30 gallons per indicated horse-power.

In a recent series of lectures on "Flame," at the Royal Institution, Sir James Dewar gave the following figures showing the efficiency of various sources of light:—Candle—Percentage of light, 2; non-luminous energy, 98. Oil—Percentage of light, 2; non-luminous energy, 98. Coal gas—Percentage of light, 2; non-luminous energy, 98. Incandescent lamp—Percentage of light, 3; non-luminous energy, 97. Arc lamp—Percentage of light, 10; non-luminous energy, 90. Magnesium lamp—Percentage of light, 15; non-luminous energy, 85. Cuban firefly—Percentage of light, 99; non-luminous energy, 1.

The Municipal Lighting Plant of the City of Seattle

By WALTER S. WHEELER

"LOWER FALLS" ON CEDAR RIVER, JUST ABOVE THE POWER PLANT

THE Washington Forest Reserve lying on both sides of the Cascade Range in the Northern part of the State of Washington comprises 5600 square miles, of which 2600 square miles lie east of the summit of the Cascade Range.

There is an abundance of water, and no irrigation would be required to cultivate the agricultural portion. The region west of the summit is composed of the spurs and slopes of the Cascades from the divide nearly down to the level country bordering Puget Sound. The altitude of the central portion of the range varies from 5000 feet in the lowest passes to more than 11,000 feet on the highest peaks. This portion of the range is extremely rugged, containing many sharp, ragged peaks and great areas so rugged as to be without soil, and consequently without vegetation, although only a trifling portion of the range is sufficiently high to be above the limits of timber. The valleys are for the most part glacier carved, and are narrow, but gradually widen toward their lower ends.

The Cascade Range in this part of Washington is composed of granite and allied rocks. It is an old range and has suffered greatly from erosion, mainly from the action of glaciers, which in recent times have occupied all the gorges leading out of the range. The abundance of water in this region may be appreciated by the statement that not a spot has been found within the reserve where the sound of falling water was not heard. Waters navigable, however, even for canoes, are short and detached. A climate more favourable to the growth of underbrush or to the starting of young trees would be difficult to find.

This short description of the Washington Forest Reserve has been given to show that water power is remarkably abundant, both on account of the quantity of water and the difference of elevation in short distances.

The headworks of the municipal lighting plant of the city of Seattle has been constructed 35 miles south of the southwest corner of this reserve on Cedar River. It is also about 10 miles south of east of the power plant at Snoqualmie Falls, a description of which was given in the ELECTRICAL AGE of April, 1904.

The city of Seattle is situated on Puget Sound, about 35 miles southwest of the southwest corner of the above mentioned reserve, and about 35 miles in a direct line from the headworks on Cedar River. We thus see that the city of Seattle, the headworks and the southwest corner of the reserve are at the corners of an equilateral triangle with sides about 35 miles in length.

Cedar River flows out of Cedar Lake, about 3 miles above the headworks. The lake is a body of water 3 miles in length and three-quarters of a mile in width. It covers 1500 acres of land, and is at an elevation of 1500 feet above mean tide. Records of the Seattle Power Company for the years 1895, 1896, 1897 and 1898 show that the flow of Cedar River at Cedar Lake varied from 200 to 4500 feet of water per second. Cedar River is also the source of Seattle's municipal water supply, and the city has purchased most of the watershed around the lake and the upper portion of Cedar River.

A timber dam has been constructed across the river, and this raises the water in the lake 14 feet above its original level. The water is carried through 14,000 feet of wooden stave pipe and 1000 feet of steel pipe to the power house, which is 600 feet below the surface of the lake. The wooden stave pipe is 50 inches in diameter, and is banded with iron hoops from one-half to five-eighths of an inch in diameter. The longest distance between hoops is 11 inches, and the least distance, where the pipe is subjected to a head of 343 feet, is two and three-sixteenth inches. With one exception, this is the greatest pressure used on wooden stave pipe.

The riveted steel pipe varies from one-fourth to eleven-sixteenths of an inch in thickness. It has been designed to withstand a static pressure of at least 50 pounds per square inch in excess of that due to head, without leak or fracture.

The power house is built on solid rock levelled up with concrete. It is 74 feet in length, 32 feet in width, and 40 feet in height. Two 1200-KW. generators are direct connected to Pelton water wheels capable of being operated at 50 per cent. overload. They are three-phase, revolving field alternators, running at 400 revolutions per minute, and developing 2300-volt current at 60 cycles. A Lombard governor controls each unit. The generators can be excited by either of two 75-KW., 125-volt compound-wound multipolar generators, direct connected to separate water wheels.

Nine 400-KW. transformers, three in a bank, raise the pressure to 44,000 volts for transmission. They are of the shell type, oil insulated and water cooled, and are located in a separate building from the generators. The high-tension oil-break switches are operated by remote control, there being no 2300-volt bus-bars, and only 125-volt direct-current on the switchboard.

One 44,000-volt, three-phase transmission line has been completed to Seattle and is in operation, and about 10 miles of a duplicate line have been constructed at the power house end, which will be built

THE PIPE LINE

through to Seattle in the near future. The wire is No. 2 B. & S. gauge copper, and is the smallest that could be used at this voltage and distance without serious loss between wires on account of the conductivity of the atmosphere. Thomas porcelain insulators made up in three parts and tested at 120,000 volts in the usual manner, are used on this line.

A telephone line of No. 11 B. & S.

gauge copper wire is carried on the same poles below the transmission wires.

The power and telephone wires are transposed, the telephone line being transposed every ten poles. The power wires are at the corners of an equilateral triangle whose sides are 84 inches long.

Eucalyptus pins are used to support the power insulators; a large pin 18 inches long being bolted to the top of the pole to support the upper wire. An extra large type of D. P. D. G. glass insulator is used on the telephone line, and the telephone wires are placed about 10 feet below the lower power wires. A good quality of cedar poles with a 9-inch top are used, and they are set from 100 to 132 feet apart. Where the line crosses railroad tracks, 75 and 90-foot poles are set close enough together so that a broken wire could not possibly reach the ground.

The sub-station at Seattle is located at the corner of Seventh avenue and Yesler Way, and is illuminated on all sides at night with thousands of incandescent lamps. A large sign at the top of the building is made up of these lamps and reads "City Light." This sign can be seen for miles out on Elliott Bay at night, as the building stands about 200 feet above mean high tide and is unobstructed.

Five three-phase two-phase transformers used in two banks of two each, with one spare transformer to take the place of any one of the other four in emergency, step the line voltage down to 2300 volts. Seven constant current transformers regulate the voltage for fourteen series street lighting circuits. Both alternating current enclosed arc lamps and 30 candle-power incandescent lamps are placed in series on these circuits. A current of 6.6 amperes is used, the arc lamps taking about 75 volts, and the incandescent lamps about 18 volts.

Three years ago the street lighting of the city was done by a private corporation at the rate of $66.00 per year per arc lamp, and $15.00 per year per 30-candle-power incandescent lamp. In order to secure some concessions at the time, this corporation agreed to put its wires underground in a portion of the business district within three years, and in another portion within five years. The city had decided to build its own lighting plant, and in order to tear the streets up as little as possible and preserve its pavements, it agreed to build a joint conduit system with this company.

A VIEW OF SUB-STATION. ONE OF THE STREET ARC LAMPS IS HERE SHOWN

A new franchise granted to this company by the city required it to construct one duct free of charge for the city's wires in every conduit containing nine ducts or less, and an extra duct free of charge for every ten ducts in excess of the first nine. The manholes and handholes along these conduits have been purchased by the city at one-half of the original cost, as provided in the franchise. We thus see that the city controls the manholes, but employees of the company can enter them upon obtaining a license from the Board of Public Works.

The city began to map in all underground structures as soon as it was decided to put in this conduit system. The plans were drawn to a scale of 1 inch equals 10 feet, and sectional maps were made at street intersections and other places where it was deemed advisable to do so.

In order to get these maps as accurate as possible, all the old records of gas mains, water pipes, steam heating mains, telephone conduits and other underground structures, were looked up with great care, and special attention was given to all openings being made in the pavements at that time. About one year after the map making began, construction was commenced on the conduits. On account of having these maps, thousands of dollars were saved in not having to open up the street unnecessarily, and much annoyance was saved the traveling public.

In addition to the ducts that the company was required to furnish the city free of charge by the terms of its franchise, the city decided to purchase at actual cost, from one to eight extra ducts in all conduit laid under brick-paved streets. In these locations the conduit varies in size from four to sixty-four ducts, the average-sized conduit containing thirty-four ducts. Vitrified terracotta, mostly of the four duct multiple type, 36 inches long, and laid with broken joints was used in this conduit. The duct was joined to-

A VIEW OF THE DAM

gether with 4-inch iron dowel pins, and each joint was wrapped with burlap dipped in oil, and then cemented over.

The ducts are encased in concrete from three and one-half to four inches thick. The concrete was mixed in the proportions of one part by measure of Portland cement, three parts sand and five parts gravel. All mortar used was mixed in the proportion of one part Portland cement to three parts sand. The concrete on the sides was tamped between the duct and a form of one inch lumber placed three and one-half inches from the duct. This lumber was left in place after the conduit was completed.

The manholes and handholes varied in size from 5 feet by 5 feet and 4 feet deep, to 9 feet by 9 feet and 10 feet deep. They were built with double brick walls and concrete bottoms. Eighty-eight manholes and handholes, and 191,948 duct feet of vitrified terra-cotta conduit were laid under brick pavement having a 6-inch concrete foundation.

The cost of this underground construction was preserved in detail, the cost of the conduit being kept separate from that of the manholes and handholes. These costs were as follows:—

Masons, 1802 hours, at 68¾cts	$1,238.87
Masons, 128 hours, at $1.03⅛ (Sat. p. m.)	132.00
Masons, 300 hours, at $1.37½ (Sunday)	412.50
Masons' helpers, 354½ hours at 20 cts. (non-union)	70.90
Masons' helpers, 1802 hours, at 37½ cts	675.75
Masons' helpers, 128 hours, at 56¼ cts. (Sat. p. m.)	72.00
Masons' helpers, 300 hours, at 75 cts. (Sunday)	225.00
Labour, 8603 hours, at 20 cts	1,720.60
Foremen, 860 hours, at 25 cts	215.00
Transitmen	140.00
Engineer	350.00
City inspection	150.00
Gas-pipe reconstruction	10.00
Cement, 802 barrels, at $2.85	2,285.70
Gravel, 77 yds. at $1.00 for concrete in bottom of manholes	77.00
Sand, 368 yds. at $1.00 for concrete and mortar	368.00
Iron rails, used as I-beams, 56.9 tons at $8.00	445.20
Brick, 208.8 m. at $10.00 per m	2,088.00
Frame and covers for manholes, 88 at $30.00	2,640.00
Repaving over manholes	160.00
Teams, 1,694 hours, at 50 cts	847.00
Total cost of 88 manholes	$14,333.52

This does not include connections to sewers, as the manholes were not connected at first. Those that collected water were afterward connected. The average size of these was 7 feet by 7 feet by 7 feet.

The rails had outlived their usefulness as rails, and were obtained at a very low figure. Their greatest cost was the cutting of them into the right lengths. They were laid close enough together to allow the laying of brick between them in cement mortar. The cost of laying the ducts was as follows:—

Labour, 94,323 hours, at 20 cts	$18,864.60
Foremen, 7,068 hours, at 25 cents	1,767.00
Pavers, 396 hours, at 66⅔ cts	264.00
Transitmen	280.00
Engineer	700.00
City inspection	320.00
Teams, 2,827 hours, at 50 cts	1,413.50
Cement, 1391.5 barrels, at $2.85	3,965.78
Sand, 682 yards, at $1.00	682.00
Gravel, 914 yards, at $1.00	914.00
Paving brick and wood blocks	50.00
Paving pitch, 13.8 tons, at $17.00	234.60
Oil, burlap, dowel pins, zinc, wear and tear of tools, etc	500.00
Lumber, 45 m. ft. b. m., at $12.00 per m.	540.00
Total cost of laying 191,948 duct ft. of conduits	$30,495.43
Vitrified clay duct, 191,948 duct ft., at 12 cts.	23,033.76
Total cost, when laid	$53,529.24

This would be an average of about 28 cents per duct foot for a conduit, laid under a brick pavement with a 6-inch concrete foundation. The high cost of the duct itself (12 cents per foot) was due to the cost of transportation from the East, and

breakage in transportation. Much of the duct that was not too badly broken, was used toward the last, zinc strips being put around the broken portion. The conduit contained from four to sixty-four ducts, the average being thirty-four ducts.

The contract between the city and the company doing the street lighting before the municipal plant was put in operation, provided that the city could purchase the street lighting circuits at the time that the contract expired, if it so desired. The city took advantage of this provision and purchased the wire in place, lamps, tub transformers, arc lighting switchboard and other miscellaneous apparatus. The city pays the company 25 cents per wire per pole per annum, for supporting these lighting wires. However, many of the poles are being maintained under franchises that require the company to reserve space for the street lighting wires free of charge, which reduces this rental considerably.

The city can also take advantage of provisions in the franchise of another company, which allows the city to string wires on this company's poles for distributing light and power to private consumers at a rental to be agreed upon between the two parties, and which rental is to be submitted to arbitration in case such an agreement cannot be arrived at.

Although the city has been lighting its streets and public buildings for several months, it is just starting into the private lighting and power business. New poles are being set, and the street lighting which took less than 500 H. P. before the municipal plant was put into operation, will soon be increased to 1000 H. P. on account of new extensions.

Allowing for loss of power in transformers, transmission and distributing lines, and assuming a reasonable power factor for different kinds of load, 1600 H. P. remains that can be sold for light and power purposes. This would not overload the generators, and as much as 2200 H. P. could be sold for a short time during the peak of the load. In the daytime, when city lights will not be needed, then about 2600 H. P. will be available for sale. These estimates as to power are to be considered as taken at the consumers' meters after allowance has been made for all losses between generators and meters.

The "all-night, every night schedule" is used in Seattle for street lighting, and this schedule is commonly called 4000 hours for the year. Much more power can be developed by building a larger dam and putting in more generators, and the plant was designed with this point in view. Leaving out the distributing lines in the city and the cost of land purchased around Cedar Lake, the development, including the transmission line, was made at a cost of about $500,000. Much additional power can be developed for a few thousand dollars.

Before the municipal plant was constructed, the small consumer paid 20 cents per kilowatt-hour for his light. He is now purchasing it at 12 cents per kilowatt-hour, and a still further reduction is looked for in the near future. The rapid growth of Seattle, which is increasing the electrical output from 25 to 30 per cent. per annum, renders the problem of construction of both generating and distributing apparatus, quite complex.

The current available at the substation is two-phase alternating current of a periodicity of 60 cycles per second, and at a normal pressure of 2300 volts. It now becomes necessary to transform this current into the various forms needed in different parts of the service. Briefly, these forms will be as follows:—2300-volt, two-phase, for power purposes; 2300-volt, single-phase, for lighting service in residence district; 250-volt, direct current, for lighting service in business district; 6.6 ampere, alternating current, for muni-

AN AIR VENT ON THE PIPE LINE

cipal street lighting service. For the 2300-volt, two-phase power, the current may pass out with the intervention of controlling and recording apparatus; the single-phase lighting circuits may be operated directly from the main bus-bars; the direct current service will be obtained through a rotary converter. The sub-station is connected by means of two-phase, 2300-volt circuits, with the sub-station of the Seattle-Tacoma Power Company, two blocks away, so that current may be obtained in case anything happens to the transmission line or other apparatus of the city. All of the wire in the distributing lines is insulated copper.

The municipal street lighting wires are of No. 6 copper, this being considered the smallest wire that could be used with safety on account of mechanical strength.

In the generating station, the switchboard is elevated at one end of the building. It is of Vermont marble and contains two panels for the generators and two for the exciters. Although polyphase instruments would have been much cheaper, and less space would have been taken up on the switchboard, three ammeters were installed on each generator panel, so that errors of instrument and unbalancing of circuits will be indicated at once.

The plant is controlled entirely from the switchboard gallery. A space of 4 feet has been left between the wall and the switchboard, and the wiring passes down the back of the board, under the floor and through the wall to an annex, where all switchboard transformers, shunts, rheostats, etc., are kept.

A wire passageway carries the leads to the transformer house. The transformer house is of stone, and is divided into three fire-proof compartments, each containing a bank of transformers all of which are placed in a single row. A path 4 feet wide, and a concrete pit runs the entire length of the building.

The oil and water pipes are carried in this pit, and it can also be used to drain off burning oil in case of fire.

A separate building has been erected for high-tension switching. It is of stone and concrete and is divided into eight compartments by concrete walls. Six of these compartments contain six triple-pole, 45,000-volt oil switches. Lightning arresters have been placed in the two end compartments, and disconnecting switches have been placed between the oil switches and the line.

The operation of the plant has been very satisfactory since the first of the year, when the street lighting load was transferred to it, and it is to be hoped that it will be just as satisfactory when the private lighting and power load is increased from time to time.

Peruvian Duties on Electric and Gas Equipments

THE New York "Commercial" recently printed the following information, received from its correspondents in Peru, relative to the duties imposed upon electric and gas equipments imported into that Republic:—

Description.	Minimum Valuation per 2.2 Pounds.	Rate of Duty.	Duty per 2.2 Pounds.
	Dollars.	Per Cent.	Cents.
General supplies, such as circuit breakers and fuses, circuit makers, keys, plugs, and electric switches of all kinds and types having china bases and tops	.60	40	24
Do., with china bases and metal tops	1.00	40	40
Do., with slate or marble bases, with or without tops	1.50	40	60
Glass insulators, gross weight	.07	40	2.8
Insulators, of clay and pottery ware, not over 0.03 meter in circumference, with or without pins, gross weight	.30	40	12

Telephones in United States Government Service

THE Weather Bureau is now distributing forecasts and special storm warnings to practically everybody in the United States. Recently, according to "The Evening Post," of New York, it has been perfecting arrangements with the telephone trunk lines by which the daily morning forecasts are made available for the use of thousands of persons who heretofore were compelled to depend on the bulletins posted at postoffices and in railway stations. With the growth of the rural telephone it is expected that, eventually, almost every American farmer will receive the daily weather bulletin in his own home before noon of the day it is issued. In some localities in Indiana, Ohio, Illinois and Pennsylvania the system of distribution has already been perfected to the point where every subscriber of a telephone company receives the day's forecast as early as noon.

Postal officials are confident that the day is not far distant when the rural telephone will become an important factor in the delivery of "hurry-up" letters. Congress has thus far declined to recognize the telephone system as a part of the postal machinery; but notwithstanding its refusal, the telephone is being brought into use daily in many rural communities by farmers who cannot even wait for the rural carrier. Senator Fairbanks planned to have Congress authorize the use of the telephone in the delivery of special letters addressed to country districts. He proposed that a special stamp should be printed, sold for 10 cents, and that when a postmaster received a letter bearing one of these stamps he should open it, reading its contents over the telephone to the farmer to whom the communication was addressed.

Some of the Senators objected to this plan because they feared it might commit the Government to a policy that would compel it to pay large annual rentals to telephone companies. But many men in the postal establishment say the new step is coming. Indeed, it is already here unofficially. By securing permission from the department a rural postmaster may now arrange with his patrons out in the country to open their letters and read the contents to them over the telephone, and farmers who have city interests that demand careful watching are making use of the permission. Congress may give its sanction to such duties at its next session.

A company has been formed in Paris for the construction of an electric railway, which is to take passengers to the top of Mount Blanc. The projected line will end at the Aiguilles du Gouter, 14,430 feet above the level of the sea, and as the work has been officially declared of urgent public utility, the construction of the line is to begin in a few months. The Jungfrau line, which is nearly completed, arrives at an altitude of 12,498 feet over the level of the sea, but has the disadvantage of running mostly through tunnels. The Mont Blanc Railway, on the contrary, will have only one tunnel, and the passengers will be enabled to enjoy the magnificent views of the Alps.

In speaking of the building of the electric tramway at Singapore, the "Free Press" of that town says that with the approaching completion of the work the rumours among ignorant natives grow apace. The latest is that 500 Chinese heads must be procured and buried under the power house before the "kreta hantu" can start running. In consequence of this jinrikisha coolies refuse to take fares into the country districts at night.

Alternating-Current Motors in Industrial Service

In a recent paper before the British Institution of Electrical Engineers, P. D. Ionides said that the great argument in favour of the alternating-current motor, particularly of the squirrel-cage type, is its simplicity and the absence of wearing parts. The argument often used against it is that it has not the advantage of shunt regulation for variable-speed work, but there are other ways in which different speeds can be obtained with equally high efficiency.

The constant-speed type of motor can be built so that it will carry 200 per cent. overload with a comparatively small drop in speed, or by changing the proportions of the windings in the secondary the motor can be made to give its maximum torque at starting.

The slip-ring motor differs from the squirrel-cage motor only in the secondary, which is coil-wound, the windings being connected to three slip-rings for starting with resistance in the secondary circuit. Once the motor is started and the secondary short-circuited, its characteristics are similar to those of the squirrel-cage type.

For starting up against very heavy loads, where gradual acceleration is required, this motor is preferable to the squirrel-cage type; moreover, starting against a given load, the starting current is not so heavy, and more closely resembles the results which can be obtained with the ordinary direct-current motor starter and shunt or compound-wound motors.

Squirrel-cage motors up to 10 H. P., obtaining their supply from a power station of 200 H. P. or 300 H. P., can be started up direct without the use of auto-transformers. This does not injure the motors in the least, but is not advisable where the generating plant is of small capacity as compared with the motors, inasmuch as it takes a very heavy rush of current at starting.

Another arrangement for starting the squirrel-cage motor is from a closed-coil two-phase generator, which is worthy of consideration when planning a new industrial plant.

For general constant-speed work the squirrel-cage motor possesses the advantage of greater simplicity, and has no disadvantages as compared with the direct-current motor. For driving spinning machinery it is particularly suitable by reason of the fact that within certain limits the speed is constant in relation to the speed of the generating plant, and independent of slight fluctuations in voltage. Again, in spinning mills and such industries it is of the utmost importance that all machinery should be started simultaneously. The squirrel-cage motor lends itself to this requirement very readily, as it is possible to leave all the motors in an installation connected directly to the line, and to start them all simultaneously by separately exciting the generator and then running up the engine.

For mining work, such as the driving of pumps, fans, and underground haulages, the squirrel-cage motor is particularly suitable, inasmuch as there are no parts other than the bearing requiring attention; again, the oil-immersed auto-starter, which can be made water and gas tight, is a form of starting switch which needs no skill or knowledge in handling. In many pits where there are explosive gases no other type of motor could be used with the same safety.

The high-lift turbine pump is gaining considerable popularity among mining engineers, and for driving this type of pump direct the squirrel-cage motor is particularly suitable, inasmuch as motors of 100 H. P. and above are frequently required, running at a speed of 1400 to 1500 revolutions per minute.

A valuable feature of the squirrel-cage motor lies in the fact that it can be actually stalled by overload for as long as half a minute without damage.

For the driving of large haulages which must be started slowly and gradually, the slip-ring motor is preferable. Any starting torque required, within reasonable limits, can be obtained without producing undue strain on the generating plant; in fact, with the slip-ring motor the proportion of current to torque developed by the motor is almost similar to the same proportion for shunt-wound direct-current motors.

The slip-ring motor is also advantageous for continual starting and stopping, as the currents broken by the controller in the secondary circuits are at low pressure. With a direct-current motor the currents broken are at line pressure.

Again, for electric braking the slip-ring motor can be used to great advantage, by so proportioning the resistance in the secondary circuit with the first or second notches of the controller as to produce a gradual braking effect when the controller is reversed. This has been applied with marked success to a 150-H. P. slip-ring motor driving an endless haulage.

In the majority of cases where speed variation is required, induction motors of either the squirrel-cage or slip-ring type may be used in the following way:—A small auxiliary motor drives the main motor through a worm gear and free-wheel clutch, so as to give the required slow speed. The main motor is wound and connected to a controller of the tramway type, so that the coils of the stator can be grouped to form eight poles, at which the medium speed would be obtained, or four poles, at which full speed would be obtained. The whole apparatus is no more costly than direct-current apparatus to accomplish the same results would have been, and the operation is equally satisfactory.

For work where it is necessary for the motor to have a speed variation of perhaps 6 or 8 to 1, with the possibility of being able to run continuously, and with high efficiency, at any intermediate speed, the single-phase series motor offers a method of accomplishing this result which is simpler and more efficient. The apparatus for this purpose will consist of a single-phase motor controlled by an induction regulator, which is a boosting transformer placed in series with the motor. Any required voltage from zero to full line pressure can be applied to the motor, and consequently any required speed can be obtained.

For variable-speed work, where constant stopping, reversing and starting again is required, both the squirrel-cage motor and the slip-ring motor may be used. With the former, the control is effected by applying different voltages to the primary by means of auto-transformers and a controller.

With the slip-ring motor, the control is effected by varying the resistances in the secondary circuit of the motor, and this method of control corresponds to inserting resistances in the armature circuit of a shunt-wound motor.

For operating winches, live rolls, and work of this class, the slip-ring motor is preferable for the reason that, in the first place, the starting currents are not so heavy, and in the second place, the currents handled by the controller are all in the secondary circuit, and consequently at a low pressure, which results in less burning of the contacts.

A clock has been introduced in Parisian public telephone offices to register the time of conversation. The dial is divided into periods of three, six, nine and twelve minutes.

The Birth of the Multi-Unit System

WRITING in the August number of "The Century," Frank J. Sprague thus describes the manner in which the idea of multiple-unit train control came to him:—

"Pondering over the elevated railway train problem one day, the thought suddenly flashed upon me, Why not apply the same principle to train operation? That is, make a train unit by the combination of a number of individual cars, each complete in all respects, and provide for operating them all simultaneously from a master switch on any car. This idea, sketched on a scrap of paper, marked the complete birth of this new method, then named and now nearly everywhere known as the 'multiple-unit system.' Its great possibilities instantly absorbed my interest, as I saw the opening of a new epoch in electric railway operation. Here was a way to give a train of any length all the characteristics of a single car, with every facility of operation which could be demanded by the most exacting conditions of service and capacity."

In describing the first application of this principle, he says:—"On July 16, 1897, two cars were put into operation on the tracks of the General Electric Company, at Schenectady, and on the 26th, the half-century anniversary of Prof. Farmer's test of a model electric railway at Dover, N. H., my 10-year-old son operated a 6-car train in the presence of the officers and engineers of the Chicago South Side Elevated Road at Schenectady.

"In November a test train of five cars was put in operation in Chicago, and on April 20 following twenty cars, seventeen of which (one in flames) were taken off during the day because of defective rheostats; but with the last 3-car train I had the satisfaction of pushing a steam train around a curve. Three months later, a year after the Schenectady test, locomotives had been entirely abandoned and the whole 120 cars were in operation, the local work being largely supervised by my assistant, Frank H. Shepard."

Alaska Cable Extension Completed

AN extension of 255 miles to the Alaska cable, connecting Seward on the coast with Valdez, until now the northern terminal of the cable reaching from Seattle, was completed on August 6. This extension was begun last March by Major W. A. Glassford, U. S. A., signal officer in charge of laying the cable. The news of the completion of the extension was received in Chicago by A. C. Frost, president of the Alaska Central Railway Company, from Major Glassford in the first message over the new line from Seward. The total length of the Alaska cable is now 1234 miles.

A Recurrence to an Old Type of Telephone Switchboard

IN Berlin, according to "The American Telephone Journal," the telephone company has a switchboard which appears to be a reversion to a type so old as to be almost unfamiliar to telephonists of to-day. The board might be said to consist of a long flat-top table, in which jacks are inserted horizontally. The signals are placed along the edge of the board, and the operators' plugs suspended in a rack in front of the signals. With this form of board, two sets of operators can be employed, one on either side of the board. In order to complete a connection, the operator must reach across the table and insert the plug.

In America this form or board was a familiar type in the old days of the Law company, and where it became a favourite with many telephone engineers. The vertical type has, so far as this country is concerned, entirely displaced it. Apparently, experience has indicated that much trouble had been had with the horizontal board, owing to the inevitable collection of dust in the interstices of the jacks, which in the vertical type is very largely avoided. It will be interesting to note whether this return to a former design will be found successful.

The twenty-fifth annual reunion of the Old-Time Telegraphers and of the Society of the United States Military Telegraph Corps will be held in New York City at the Waldorf-Astoria, August 29, 30 and 31, and September 1. John C. Barclay, general manager of the Western Union, is president of the Old-Timers, and W. B. Wilson, of Philadelphia, is president of the Society. The banquet will take place on Thursday, August 31.

Three funeral cars are among the equipment of the United Railroads of San Francisco. A motorman's cab is at one end, and there is a compartment for the casket and flowers, one for the mourners and one for the friends of the deceased.

A Telephone in Salt Lake

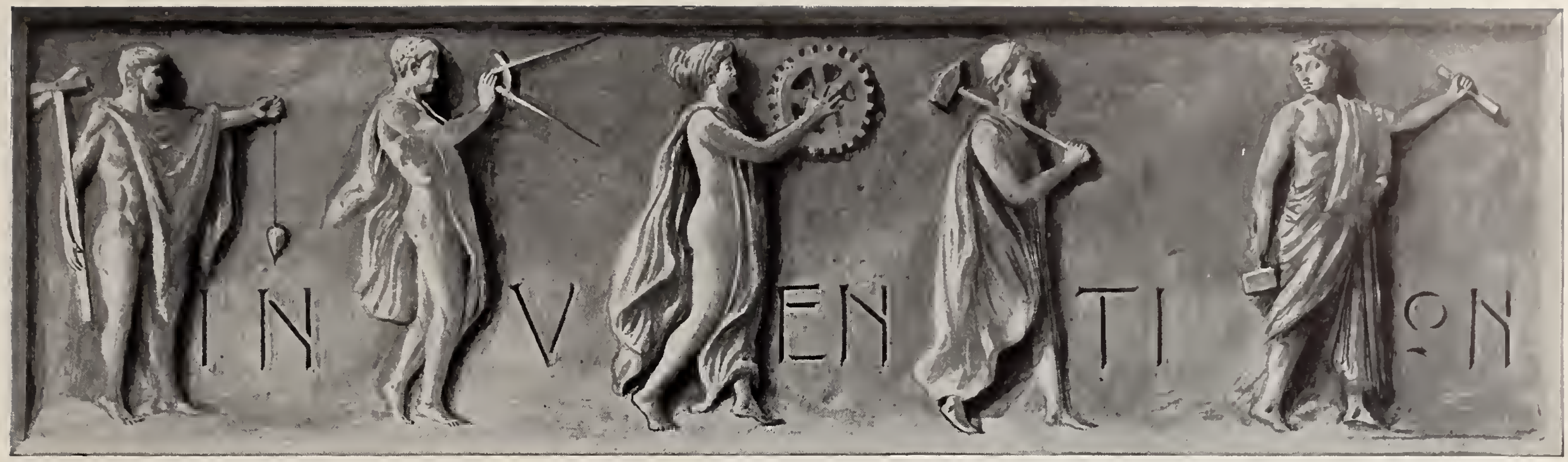
AT a prominent bathing place near Salt Lake City, a telephone has been installed 3000 feet out in Salt Lake and connected with an exchange on shore. According to the "Western Electrician," the primary object of the telephone was to summon aid to bathers in cases of imminent drowning. To make the system work satisfactorily is said to have presented difficulties, and perfect insulation was required to resist the salt water of the inland sea. Now it is possible to communicate with Spokane, Denver and the cities of Wyoming, Idaho and Utah while bathing in the Salt Lake.

A Magnetic Survey of the North Pacific Ocean

THE department of international research in terrestrial magnetism of the Carnegie Institution at Washington is about to begin a magnetic survey of the North Pacific Ocean. Dr. L. A. Bauer, who is in charge of similar work for the United States Coast and Geodetic Survey, will direct the expedition. A wooden sailing vessel, the "Galilee," has been fitted out for the expedition.

One of the most interesting discussions at the recent Denver meeting of the National Electric Light Association was that on the paper relating to protection from lightning and other static disturbances, presented by Messrs. Alex Dow and Robert Stuart Stewart, of Detroit. It was decided to have investigations on this subject continued throughout the year and the results presented at the next convention, and President Blood has appointed for this purpose a committee consisting of Messrs. Dow and Stewart and Orville A. Honnold, of Salt Lake City. Mr. Dow is chairman of the committee. All of these gentlemen have had abundant opportunity to gather experience that will be valuable, and it is expected that all the members of the association will send to Mr. Dow any data they may have that can be of use to the committee.

Experience with motor omnibuses and electric railway cars in Great Britain has shown, according to U. S. Consul Frank W. Mahin, at Nottingham, England, that the electric motor-driven vehicle is much simpler and possesses superior power in sundry ways in comparison with a petrol motor vehicle.



Electrical and Mechanical Progress

Stombaugh Guy Anchors

THE time occupied in anchoring guy ropes used in telegraph and telephone line construction is often considerable. The manner in which W. N. Matthews & Bro., of St. Louis, seek to reduce this by the use of the Stombaugh guy anchor is well shown in the annexed illustrations.

The anchor is similar at the bottom to an auger, and bores its way into the earth when turned. The method of installing these anchors is as follows:—

For 5 and 6-inch anchors without rods, a piece of galvanized strand or wire, 7 or 8 feet long, is tied to the eye of the anchor and then passed through the hollow shank of the wrench, as shown in Fig. 1. The anchor is then keyed to the wrench and the strand is clamped at the top. The anchor is then screwed into the ground at the angle at which the guy wire is to run, the clamp on the strand is taken off and the wrench removed. The guy wire is then fastened to the strand.

FIG. 1.—A STOMBAUGH GUY ANCHOR MADE BY W. N. MATTHEWS & BRO., ST. LOUIS, MO. THE METHOD OF INSTALLING 5 AND 6-INCH ANCHORS WITHOUT RODS IS HERE SHOWN

FIG. 2.—SCREWING AN 8, 10 OR 12-INCH ANCHOR INTO THE GROUND

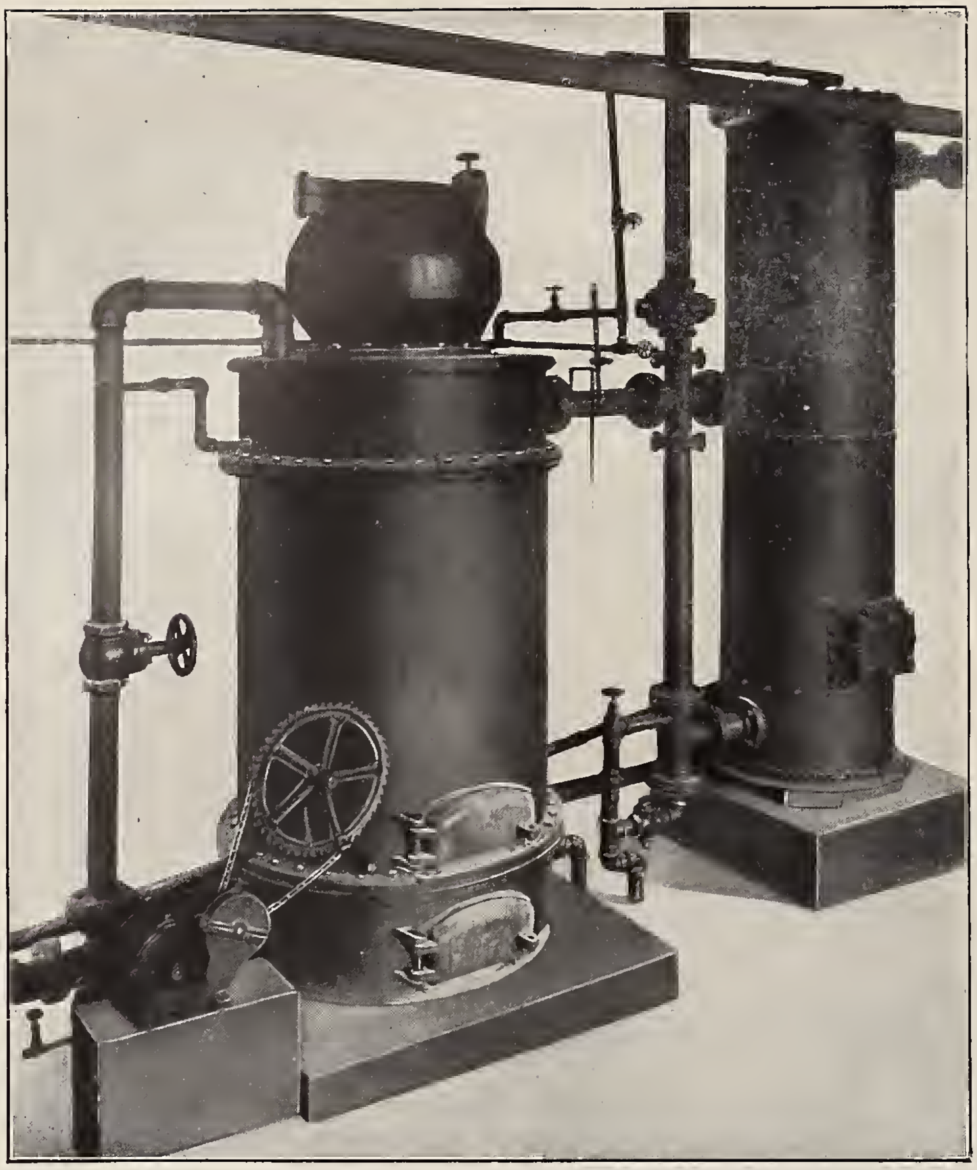
Fig. 3 shows the wrench fitted with a 5 or 6-inch anchor having a rod with an eye. A wooden or metal wedge is driven into the eye to keep the wrench from slipping off the anchor.

Fig. 2 shows the method of installing 8, 10 and 12-inch anchors. These have heavier rods than the 5 and 6-inch, and are screwed into the ground by means of a bar placed in the eye, as shown. In very hard ground a lever is clamped to the rod a foot or so above the ground and is moved up as the anchor goes in.

When the anchors are bored 5 feet into the ground, their holding power varies from 12,500 pounds with the 5-inch to 30,600 pounds with the 12-inch size.

In hard ground the work will be much easier if a hole is made with a crow or digging bar or a wood auger with a long shank. A little water

FIG. 3.—READY TO INSTALL 5 OR 6-INCH ANCHORS WITH RODS



A SUCTION GAS PRODUCER PLANT BUILT BY OSKAR NAGEL, NEW YORK

poured down this hole before starting the anchor will help considerably where the ground is hard and dry. The anchor will also start easier if a few spades of earth are removed at the angle desired to set the guy, or if a man stands on the helix of the anchor when starting until the point bites the ground.

Suction Gas Producers

THE advantages of suction gas producers for generating gas for use in gas engines driving electric generators or furnishing power for industrial purposes are now well recognized. The plant shown in the annexed illustration is working successfully in the machine shop of the F. W. Horstmann Company, East Newark, N. J., in which illuminating gas was formerly used. The plant was built by Dr. Oskar Nagel, of New York city, and is said to be working according to the guarantee given with the plant; that is, the development of 1 B. H. P. hour from $1\frac{1}{4}$ pounds of anthracite (pea) on full load, $1\frac{1}{3}$ pounds on three-quarter load, and $1\frac{1}{2}$ pounds on one-half load.

The plant has a capacity of 20 H. P., and consists of a hand-blower, a producer, with an evaporator on top, and a scrubber. The overflow water-pot is in the pit between the producer and the scrubber, and a small equalizing tank is connected on the floor below to the engine so as to connect the scrubber with the latter.

By the suction of the engine, the air is drawn over the surface of hot water in a water-jacket and saturated with steam, and this saturated mixture of steam and air is drawn through the fuel, and the producer gas thus generated. From the producer the gas goes through the scrubber, which is filled with coke, and is freed from dust and tar by means of water. From the scrubber, the gas goes to the engine through the equalizer, a simple iron drum.

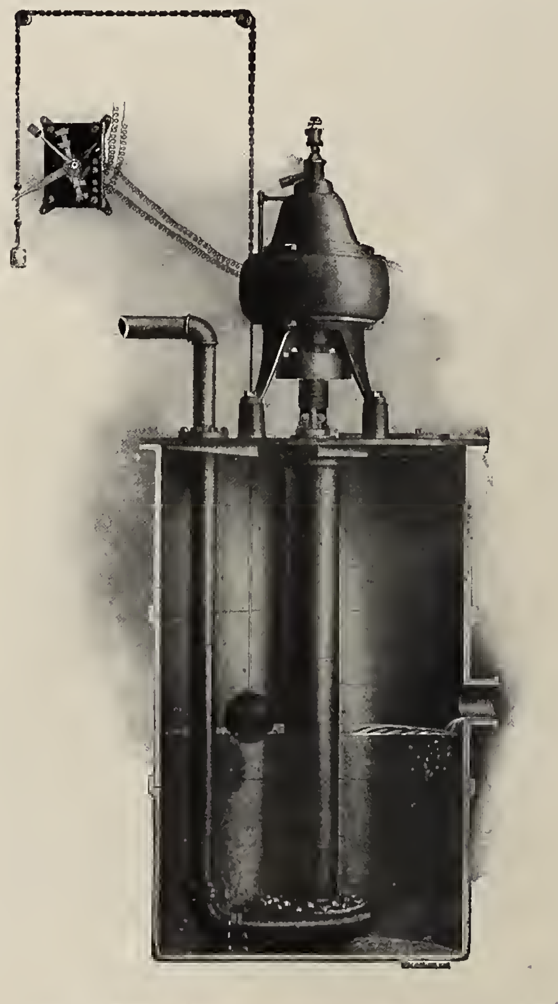
This plant is provided with a hopper sufficiently large to contain fuel for the whole working day, so that no refilling with coal is required during the working hours. After shutting down over night, the lower door and the valve leading to the flue are kept somewhat open so as to keep up a little draft and maintain the fire. In the morning, before starting up, the fire is cleaned from the ashes and the hopper filled with coal. The fire is then blown hot for about ten to fifteen minutes by means of a hand blower until the gas is burning well at the test cock, and then the engine is started as usual. During the working day the plant requires no attention except cleaning the grate once or twice a day.

A similar plant at the elevator of the Stockbridge Elevator Company, Stockbridge, Mich., is working successfully on the changing load. This plant used a gasoline engine until a short time ago, and has now installed this producer, which works very satisfactorily on the engine after the compression in the latter has been increased sufficiently. The saving in both of these plants is such that the first cost of the plant is recovered by the saving in less than one year.

A Motor-Driven Bilge Pump

A NEW motor-driven bilge pump, designed by the Goulds Manufacturing Company, of Seneca Falls, N. Y., for pumping sewage, draining cellars, basements and the like is illustrated on this page.

It is arranged for automatic control, the rise and fall of a ball float actuating an automatic tank switch which starts and stops the motor. When the liquid reaches a certain height in the cesspool, the motor



A MOTOR-DRIVEN BILGE PUMP BUILT BY THE GOULDS MANUFACTURING COMPANY, SENECA FALLS, N. Y.

starts and continues to run until the cesspool is nearly empty. The ball float again operates the switch and the motor stops. Sufficient liquid remains to keep the pump always submerged so that it cannot become airbound or lose its suction, and of course no priming is necessary.

The pump, discharge pipe and motor are all supported by the heavy iron pit cover, so that the entire outfit can be removed for repairs or inspection by simply lifting the cover. The shaft connecting the motor and pump is protected from the action of the water by a sleeve, and the thrust bearing that takes the weight of the motor and runner is above the iron pit cover. The pump illustrated is built for a pit 5 feet deep, has a capacity of 200 gallons per minute for a total lift of 25 feet, and is operated by a 2-H. P. motor, built by the Northern Electrical Manufacturing Company, of Madison, Wis. These outfits may be built for any capacity and to suit any condition of service.

A New Direct-Connected Engine

THE new enclosed, self-oiling, direct-connected engine of the Chandler & Taylor Company, of Indianapolis, Ind., shown in several accompanying illustrations, is built in accordance with the recommendations of a joint committee of the American Society of Mechanical Engineers and of the American Institute of Electrical engineers as to speed, size of unit, and size of shaft.

The bearings of the engine are designed so that they will not shift sidewise as the shaft journal wears, thereby ensuring at all times a proper position of the armature in the center of the magnetic field.

The cylinder is shown in section in Fig. 3. The valve rod and piston rod stuffing-boxes are very simple, and can be used either with ordinary or metallic packing. They are made of brass throughout to prevent corrosion, and being drawn up by a single nut, an equal pressure is given to the packing, and it is impossible to chafe or cramp the rod.

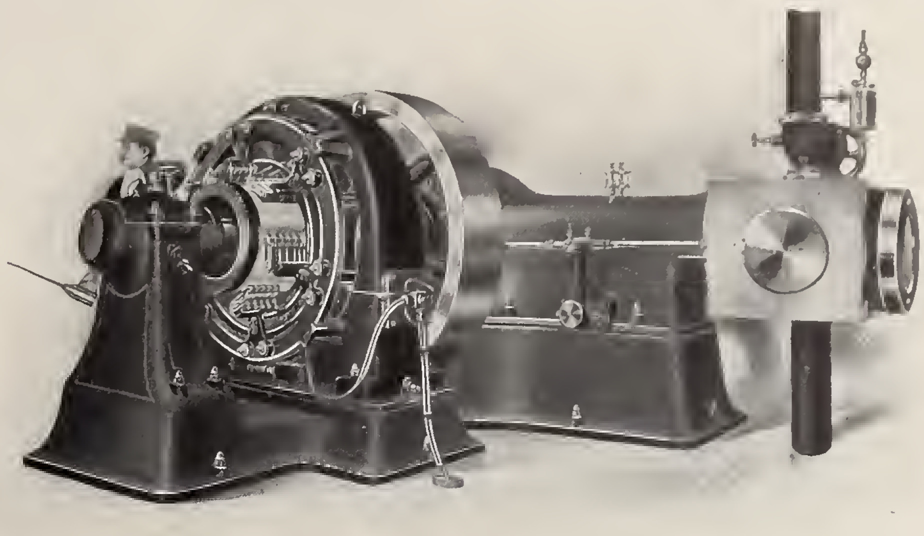


FIG. 1.—A DIRECT-CONNECTED ENGINE BUILT BY THE CHANDLER & TAYLOR COMPANY, INDIANAPOLIS, IND.

The type of governor used is the well-known Rites governor, manufactured under the Rites-Carpenter patents. This governor embodies in a single weight both the centrifugal and inertia principles in regulation. There are only three essential features; the inertia arm, the pin which supports it, and the spring. No dash pots are needed, and the usual numerous joints are dispensed with. The inertia arm is designed in such a way as to eliminate cross balance in the governor. By this arrangement the center of gravity of the two ends is at all times in a line perpendicular to the center of the governor pin. It will readily be seen from the view of the governor here shown that when weight is added to either end of this inertia arm and an equal amount placed on both sides, the line of the center of gravity of the whole remains unchanged. This method of weighting eliminates the objectionable cross balance, which is detrimental in many ways.

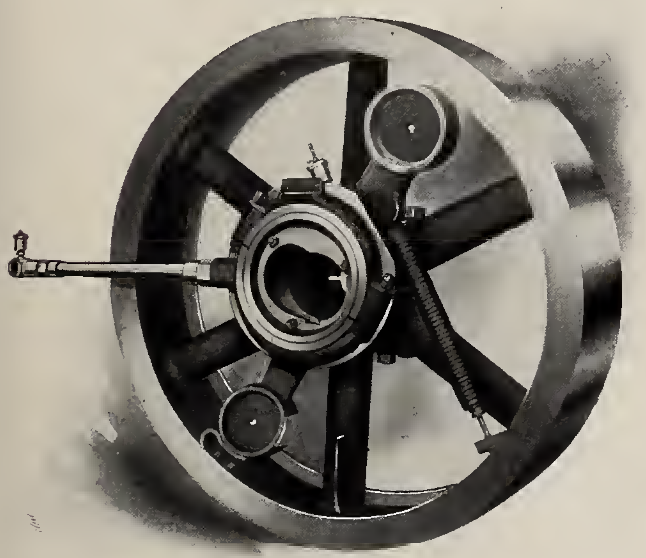


FIG. 2.—THE GOVERNOR USED IN THE CHANDLER & TAYLOR DIRECT-CONNECTED ENGINE

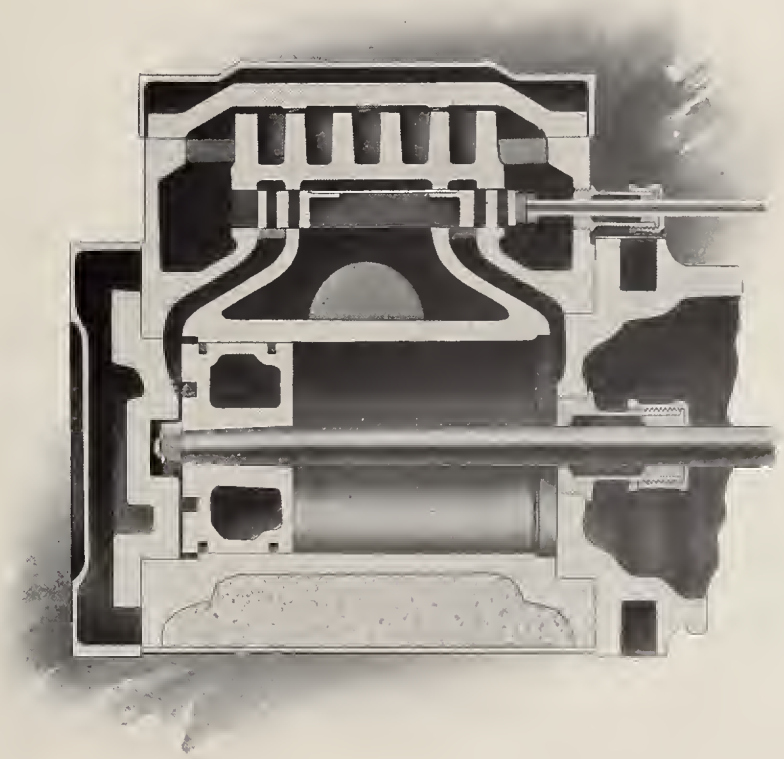


FIG. 3.—LONGITUDINAL SECTION OF CYLINDER AND VALVE CHEST OF THE CHANDLER & TAYLOR ENGINE

The engine frame and crank oil guard have been designed so as to prevent the engine from throwing oil, and at the same time to render it accessible for inspection and adjustment.

The main shaft bearings are provided with continuous chain oilers, fed from a reservoir below. The governor pin and the bearings on the rocker arm are provided with grease cups. All other bearings requiring lubrication have individual sight feed oil cups, which are placed in convenient positions so that they can be easily refilled when necessary. Each engine can be operated as a self-oiling splash engine, or not, as the purchaser may prefer, but unless instructions are given to the contrary, engines will be arranged to be run self-oiling. In order that a constant quantity of oil may be maintained in the crank case, an overflow into the reservoir in the sub-base of the engine is provided. Means are at hand by which this surplus oil can be drawn off from this reservoir at necessary intervals, filtered and used again.

A New Induction Motor

A NEW induction motor built by the Richmond Electric Company, of Richmond, Va., is shown in the illustrations on this page.

Fig. 1 is a general view of the motor, and Fig. 3 shows the windings of the stator. By using very thin sheet steel of a high grade, it is the company's aim to reduce the hysteresis loss in the stator to a minimum, and to make the heat losses almost negligible by using low-resistance windings. Fig. 2 shows the rotor. This has heavy, imbedded copper bars, and the secondary resistance is placed in the end rings where ample ventilation is provided.

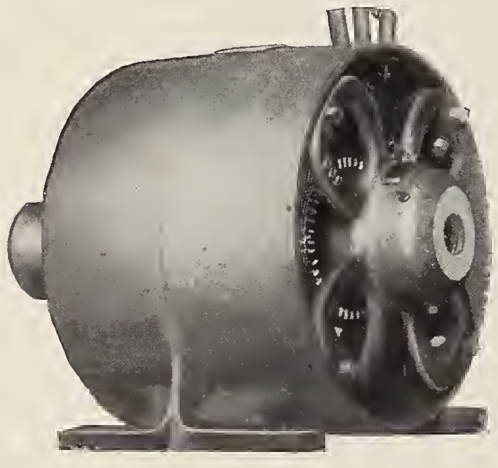


FIG. 1.—A NEW INDUCTION MOTOR BUILT BY THE RICHMOND ELECTRIC COMPANY, RICHMOND, VA.

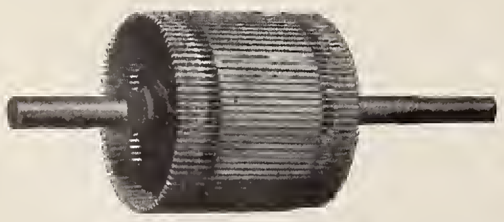


FIG. 2.—ROTOR OF THE RICHMOND INDUCTION MOTOR

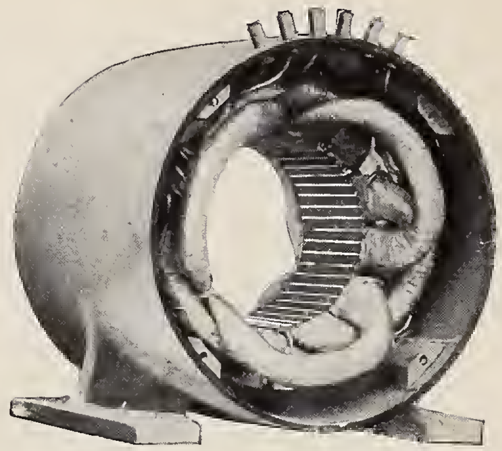


FIG. 3.—THE STATOR OF THE RICHMOND ELECTRIC COMPANY'S INDUCTION MOTOR

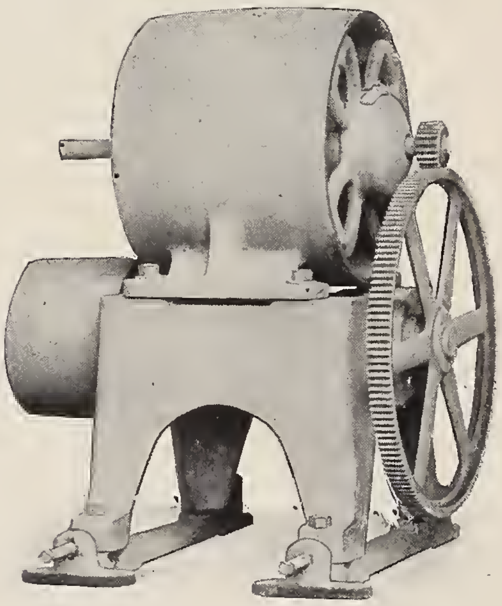


FIG. 4.—AN ARRANGEMENT OF THE RICHMOND INDUCTION MOTOR WITH REDUCTION GEARS FOR SLOW-SPEED USE

The bearings are of aluminium bronze, split, and are ring-oiled. Large oil chambers provide ample storage capacity. The heads are held by four cap screws, and can be readily turned so as to suit the motor for floor, wall or ceiling use. Malleable-iron skids are provided and may be bolted to ceiling timbers, the motors being swung from the skids, thus giving belt-tightening adjustment on the ceiling as on the floor.

Induction motors of very slow speed are not recommended, except at low cycles. With a properly designed induction motor with liberal bearings and oil chambers and well balanced rotors, excellent service will be obtained in small sizes up to 1700 revolutions per minute, and in larger sizes up to 1150 revolutions per minute. The fewer the poles on a given size frame, the better the efficiency, starting torque, etc. Speed should be limited only by mechanical consideration and the necessity for connection to load.

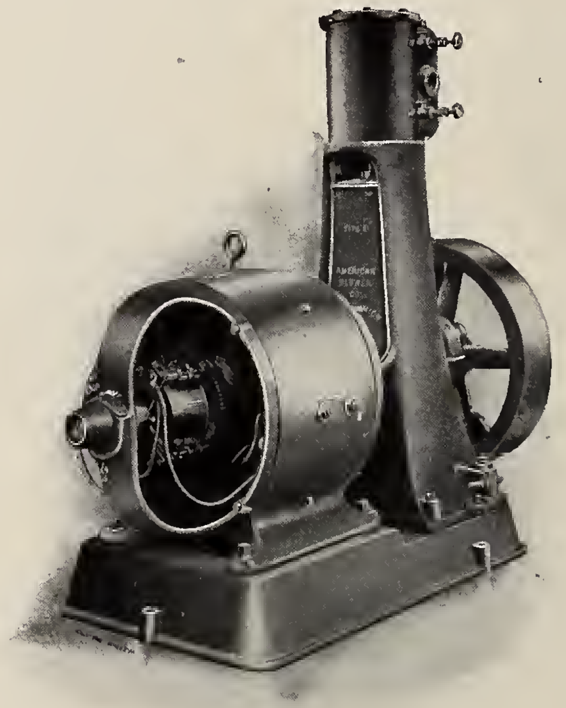
For slow speeds the back geared motor, shown in Fig. 4, is recommended. By this, it is claimed, almost any desired speed can be obtained and high electrical efficiency and starting torque preserved. This back-geared motor lends itself to floor, wall, or ceiling use, and the rawhide pinion reduces the gear noise to such an extent that it is usually unnoticeable or certainly unobjectionable. For variable speeds, two step-cone pulleys of different sizes on each end of the shaft are recommended. Where very slow speeds are required, cones can be placed on the back-geared motor shown in Fig. 4.

The motors are built for any phase, cycle or voltage in sizes of 1, 2, 3, 5, $7\frac{1}{2}$, 10, 15 and 20 H. P.

A New High-Speed Steam Engine

A NEW high-speed engine, built by the American Blower Company, of Detroit, Mich., is shown in the annexed illustration direct connected to a generator.

The engine is of the vertical, enclosed type. The entire space beneath the crank is an oil reservoir, in which the oil is filtered and from which it is pumped up into a funnel-shaped strainer, running thence by gravity into a tray cast on one of the panels. From this tray, brass



A NEW ENGINE BUILT BY THE AMERICAN BLOWER COMPANY, DETROIT, MICH., DIRECT CONNECTED TO A GENERATOR

tubing leads the oil to the various parts of the engine. The upper ends of the tubes project up nearly level with the top of the tray and are provided with a narrow slit to allow the oil to run evenly into all the tubes and also to prevent clogging.

The cylinder and steam chest are cast in one piece and are bolted to the top of the frame. The valve is of the piston type. The piston is fastened to the rod by forcing up to a shoulder, the projected end being threaded to receive a nut and riveted over when the nut is screwed down.

The cross-head is of cast steel and the shoes are of the wedge type and of a special brass composition. The guides are cast with the frame, and the connecting rod is of drop-forged steel, the crank end being of the marine type.

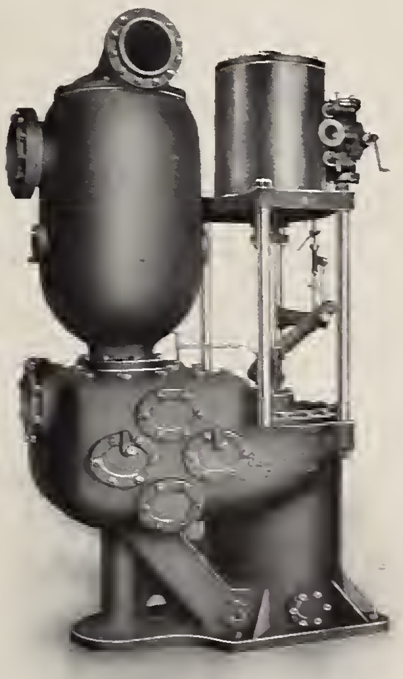
The crankshaft is a steel forging of large diameter and is provided with counter-balance weights of cast iron. The latter are attached by bolting to the ends of the crank cheeks. A hole is cored in each weight, and after the bolt is set up tight, lead is poured into the hole to prevent the bolt working loose and, incidentally, to add to the weight of the counter-balance.

The fly-wheel is fitted with a Rites governor, the weight being provided with a device of the company's design to shift the spring-lever arm and enable the operator to obtain regulation over a wide range of speeds. Drain cocks of the automatic relief type with hand valves are provided. The engines are built to standard dimensions by means of jigs, templates and gauges, making all parts interchangeable.

Jet Condensing Apparatus

THE jet condensing apparatus shown in the annexed illustration, and built by the Dean Brothers' Steam Pump Works, of Indianapolis, Ind., is for converting a non-condensing or high-pressure engine into a condensing engine. If an engine is rather small for its work, by adding this condenser, it is claimed, its power can be increased from 20 to 30 per cent. without increasing the steam consumption, or, in other words, without increasing the boiler capacity. If the engine is large enough for the work, then the condenser will effect a saving of 20 to 30 per cent. of the steam used.

These air pumps and jet condensers are made with the company's patent noiseless steam valve gear. The stroke is adjustable while running. Spray plates and flanges are provided for thoroughly mixing the water with the incoming steam. They are fitted with automatic break vacuum apparatus: the valves are water sealed, and the piston rods have double stuffing boxes and water chambers for sealing them against air leakage. Thermometers are attached for indicating the temperature of the waste water. Other advantages claimed for this apparatus are that it occupies but little room: it produces its own vacuum before the engine is started: it adds nothing to



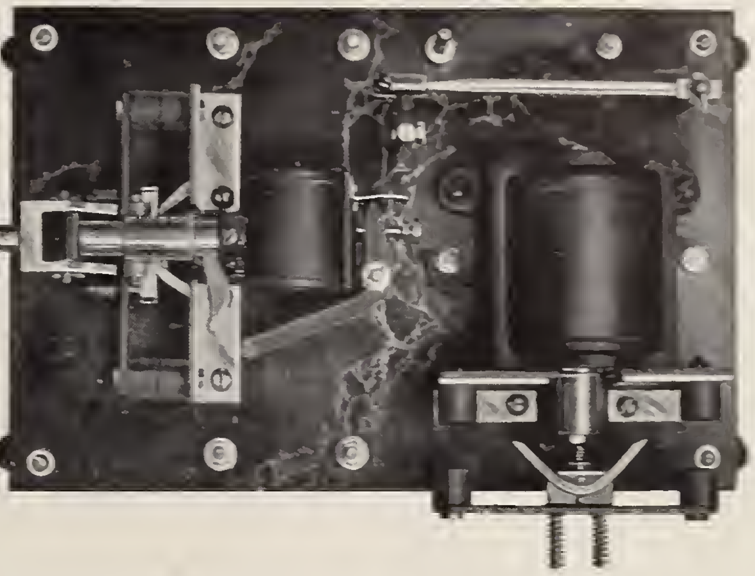
AN AIR PUMP AND JET CONDENSER BUILT BY THE DEAN BROS. STEAM PUMP WORKS, INDIANAPOLIS, IND.

the engine load, and it lifts its own water.

The cylinder is bronze lined. The valves are accessible through large hand holes, and the upper head of the air cylinder can be taken off without disturbing any other part.

A Motor Controller for Small Movements of Machines

A MOTOR controller, made by the Globe Electric Controller Co., of Amsterdam, N. Y., for use in "edging forward" machinery, is shown in the annexed illustration. When a standard starting box is used



A NEW MOTOR CONTROLLER MADE BY THE GLOBE ELECTRIC CONTROLLER COMPANY, AMSTERDAM, N. Y.

for this purpose, it involves serious injury to the first contacts. When the operator moves the contact lever forward in order to start the machine and then immediately withdraws the lever, serious arcing will invariably occur as a result.

As an example, in printing press work it is necessary in placing the plates upon the cylinders to move the cylinders a fraction of a turn at a time. In order to do this the motor must be furnished with a large current for an instant only. Heavy machine tools are required to be moved short distances for convenience in setting up the work, and the like.

The controller illustrated consists of a single-pole circuit breaker in combination with a magnet switch operated by one or a series of push buttons. When it is desired to move the machine forward, it is only necessary to touch the push button for an instant, thereby completing the circuit through the magnet switch. The switches furnish a large amount of current to the motor for an instant, thereby causing the latter to move forward as far as is desired.

As will be supposed, this starting device must be capable of withstanding very severe service, and in consequence is constructed in a very substantial manner, so as to be easily capable of withstanding the severest service possible. The construction is simple and, where arcing is liable to occur, the parts may be renewed

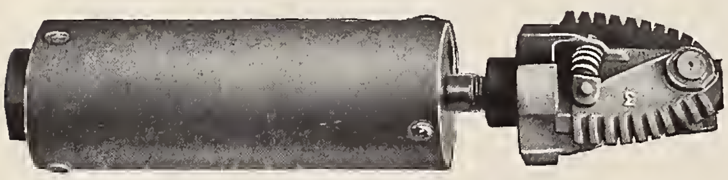
easily and at a very little cost.

The circuit breaker is of a single-pole, double-breaker type. The customary toggle joint is superseded by a small cam lever. By using this device in addition to the usual controller, it is claimed, an immense amount of time and labour is saved in setting up work or in getting machines ready for operation. It is a desirable feature in large machine shops, printing press rooms, and the like.

An Improved Water-Tube Cleaner

An improved cleaner made by the General Specialty Co., of Buffalo, N. Y., for removing scale from water-tube boilers is shown in the illustration on this page. The cleaner is driven by water pressure acting on pistons, producing a rotary movement of the cutters. The latter are forced out by powerful springs, their action on the scale being, it is claimed, neither of a chopping nor grinding nature, but that of a direct cutting tool.

The outward movement of the

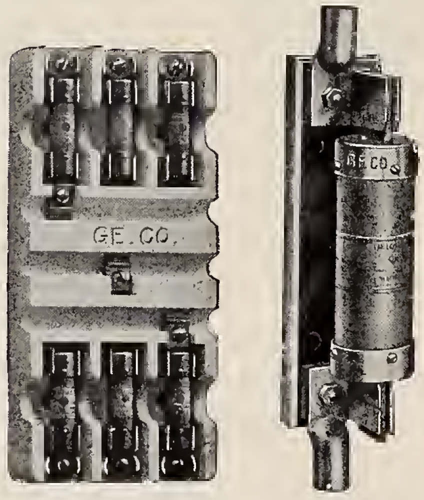


A WATER-TUBE CLEANER MADE BY THE GENERAL SPECIALTY COMPANY, BUFFALO, N. Y.

cutters is limited by properly arranged and adjustable stops, which, it is claimed, not only prevent injury to the tube, but relieve the cutters of excessive wear. The cutting tool is mounted directly on the shaft of the motor, and the latter is properly centered in the tube by six centering lugs, all of which insure thorough and uniform work on all sides of the tube. The cleaner may be attached directly to the water supply main, and can be easily operated by one man. The bearings are of the roller type, and are made of tool steel properly hardened. Where there are two sizes of tubes, an adjustable or combination cleaner is supplied, if a separate one is not desired for each size.

Enclosed Fuses and Cut-Outs

The General Electric Company, of Schenectady, N. Y., is now furnishing a complete line of National Electrical Code standard enclosed fuses and cut-outs ranging from 3 to 600 amperes in both 250 and 600 volts. Some of them are shown in the illustrations herewith. Fig. 1 shows a 3-wire, double-branch, 250-volt, 3-30-ampere cut-out; Fig. 2 a single-pole, 600-volt, 401-600-ampere cut-out; Fig. 3 a 250-volt, 31-60-ampere fuse; Fig. 4 a 250-volt,

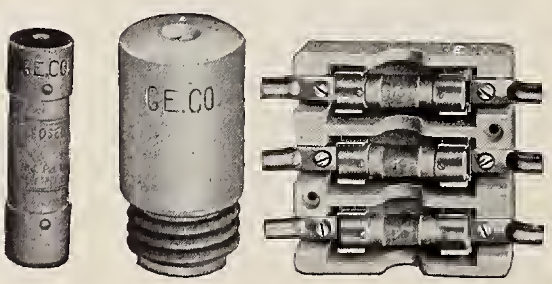


FIGS. 1 AND 2.—CUT-OUTS MADE BY THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

30-ampere, removable fuse plug, and Fig. 5 a 3-wire, main-line, 250-volt, 31-600-ampere cut-out.

For fuses rated from 3 to 30 amperes at 250 volts, cut-outs similar to the Edison plug cut-outs are furnished, and for fuses of 31 to 60-ampere capacity at 250 volts, 2 and 3-wire main-line and single-branch cut-outs are supplied. All other sizes of fuses are provided with single-pole cut-outs. With all cut-outs are used wrought copper cable terminals, with the exception of the 30-ampere, 250-volt sizes. These are provided with washer and screw terminals.

The fuses are of the well-known enclosed type, ferrule or knife-blade contacts being used, according to the requirements of the Code. The knife-blade type, in addition to the standard parts, has a brace placed in each



FIGS. 3, 4 AND 5.—FUSES AND CUT-OUT MADE BY THE GENERAL ELECTRIC COMPANY

end of the tube to engage the screws which hold the end caps in place. The brace is rigidly attached to the contact blades, forming a strong mechanical joint which does not depend solely upon the shearing strength of the fibre tube. The knife-blade contacts are of punched copper, and when used with the standard switch clips provide the best form of contact. The parts being copper of high conductivity generously proportioned, the heating is reduced to a minimum.

In the ferrule type the contacts are made by phosphor bronze clips designed to give the utmost contact and elasticity in the smallest possible space.

The renewable fuse plug consists of a brass tube with the lower end threaded to fit the standard screw shell, and the upper part insulated by a porcelain shell. In the upper end also, a spring clip receives the ferrule contact of the reload, the ferrule on the other end forming the center contact of the plug. The reloads are the 30 and 60-ampere, 250-volt enclosed fuses.

An Air Deflector for Electric Fans

An electric fan air deflector recently placed on the market by the Henry D'Olier, Jr., Co., of Philadelphia, is shown in the annexed illustrations. It consists of a sheet-brass disk, 14 inches in diameter, properly slotted and bent, as shown in Fig. 1.

It can be readily placed on any ordinary fan. When in use, the air displaced by the fan is distributed over a large area. Any one sitting directly in front of the fan, under ordinary conditions, feels a strong

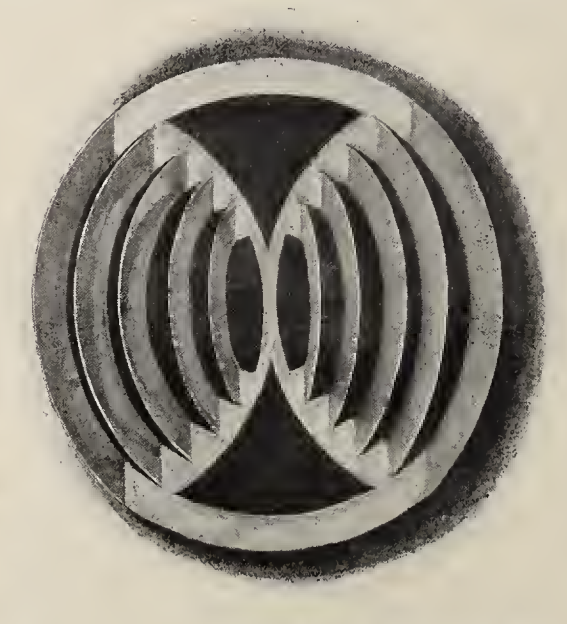


FIG. 1.—AN AIR DEFLECTOR FOR ELECTRIC FANS MADE BY THE HENRY D'OLIER, JR., CO., PHILADELPHIA

draught, which often is very objectionable. Ordinarily, to eliminate this objectionable feature, the fan is turned, thus not giving the full benefit of the fan to the user.

By placing the air deflector on the front of the guard a marked change will result. In Fig. 2, the ribbons

are attached to the guard, and the air is shown by the directions of the ribbons to be concentrated. With the deflector, however, the air is distributed over a large area, thus

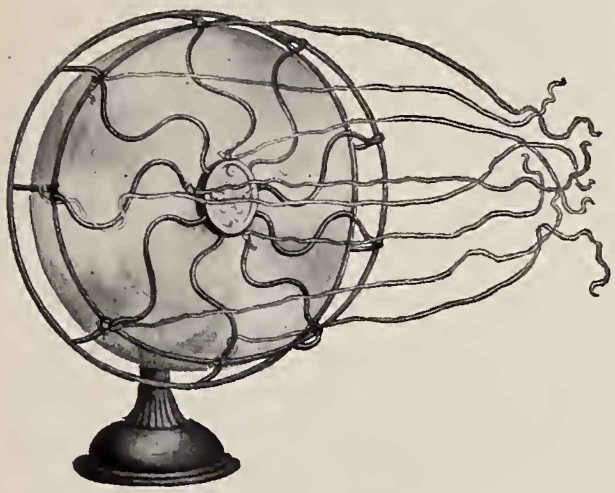


FIG. 2.—WHEN THE DEFLECTOR IS NOT IN USE, RIBBONS ATTACHED TO THE GUARD SHOW THE AIR TO BE CONCENTRATED. WITH THE DEFLECTOR IT IS DISTRIBUTED OVER A WIDE AREA

doing away with the strong draught in one direction. In lots of 9 or less the price is $1.25 each, and in lots of 10 or more, $1 each.

Personal

W. E. Harrington, formerly general manager of the Public Service Corporation at Camden, N. J., is now the general manager of the Camden & Trenton Railway Company, with headquarters at Riverside, N. J.

W. A. Blanck, formerly electrical engineer of the Chicago & Milwaukee Electric Railroad Company, at Highwood, Ill., recently opened an office as consulting electrical engineer in the Fisher Building, Chicago.

C. A. White, representing the Ames Iron Works, builders of engines and boilers, has removed to 85 Liberty street, New York City.

A. H. Whiteside, who has for a considerable time been manager of the Allis-Chalmers Company's district office at Atlanta, Ga., was transferred on July 15 to the Philadelphia district office, where he succeeds as manager W. A. Wood, resigned.

The Westinghouse Company were represented at the recent exhibition at Boston of the National Electrical Contractors' Association by the following attaches of the main and district offices:—R. L. Warner, New England manager; D. E. Manson, manager Boston office; C. B. Humphrey, manager detail sales; G. B. Griffin, assistant manager detail sales; T. B. Whipple, general lamp agent; J. William Smith, cashier Sawyer-Man Electric Co.; Messrs. Watts, Merrill, Bates, Osborn, Gibbs, Bond, Chase, Wahn, Abbott, Walton and Ewing, of the Boston office of the Westinghouse Electric & Manufacturing Company; D. E. Clark, manager of the Westinghouse Machine Company; A. T. Holbrook, manager Boston office, Nernst Lamp Company, and J. C. McQuiston, superintendent of the Westinghouse Companies' publishing department, who had charge of the Westinghouse exhibit.

Herbert Laws Webb, the telephone expert, has just returned to England after giving evidence at Ottawa, Can., before the Parliamentary Telephone Committee there, which is now making inquiry in regard to the craze for the municipal ownership there of telephone plants. Mr. Webb's testimony was most interesting, and was emphatic as to the superiority of American telephone work free from government ownership.

The interesting announcement has been made that W. S. Barstow and Frank R. Chambers, Jr., the latter recently connected with Messrs. J. G. White & Co., of New York, have formed a copartnership as consulting electrical engineers, to do a general business in the West. The new firm, known as Barstow & Chambers, have opened offices in Portland, Ore., but will also maintain an office at 56 Pine street, New York.

William B. Rankine, of the Niagara Falls Power Company, will spend the remainder of the summer abroad, having recently sailed for rest and recreation.

W. J. Buckley has been appointed manager of the Allis-Chalmers Company's district office at St. Louis. H. P. Hill, whom he succeeds, goes to the Salt Lake City district office, where he will devote himself to his specialty, the electrical features of the company's business. The Allis-Chalmers Company has never before had its electrical department's products directly represented in that district.

Arthur Koppel, manufacturer of industrial, narrow and standard-gauge railway materials, at 68 Broad street, New York, referring to the item which we printed last month concerning the organization of the Ernst Wiener Company, writes to us as follows: "We desire to call your attention to the fact that Mr. Carl Koch, mentioned in your last issue as being associated with Mr. Ernst Wiener, formerly employed by us, at no time occupied the position of chief engineer, though he was one of our engineering staff. Only a few men decided to join the forces of the Ernst Wiener Company, so that we were in no way hampered as far as carrying on business is concerned. You will oblige us by making mention of this in your columns, and thus help to prevent the forming of any wrong impressions as to our business."

W. H. Blood, the newly elected president of the National Electric Light Association, was in New York recently consulting with several of the officers of the association regarding the policy to be pursued during the present year. President Blood intends to make a number of appointments of committees in the near future, with a view of having active work taken up at once and continued throughout the year, in addition to the routine work of the secretary's office. A number of new members were added to the different classes at the Colorado meeting, and interest in the association was never so keen as at the present time.

Wallace M. Probasco, formerly an assistant manager of the Westinghouse Companies' publishing, advertising and exhibition interests, is now the vice-president of the Searchlight Publishing Company, of New York City, devoted mainly to the publishing and advertising interests of important manufacturing and engineering firms and railroads.

W. M. PROBASCO

M. W. Thomas has been appointed manager of the Allis-Chalmers Company's district office at Atlanta, Ga.

Mr. Thomas is widely known in the South, where he has been identified for years with electrical and machinery interests. He was until recently manager of the Westinghouse Electric & Manufacturing Company's office in New Orleans, and brings to the Allis-Chalmers Company the advantages of a large and valuable acquaintance.

Arthur Williams, of the New York Edison Company; C. L. Edgar, of the Boston Edison Company, and Dr. A. E. Kennelly, of Harvard University, are abroad for rest and recreation. Incidentally, however, Mr. Williams is going to look into the municipal ownership situation on the other side.

Other men in the electrical field upon whom the other side of the Atlantic has exercised its charms this summer, are George Westinghouse, who has just gone over on an extended trip, and B. H. Warren, president of the Allis-Chalmers Company, who recently returned after a stay of about three months in England. T. D. Lockwood, of Boston, connected with the Bell Telephone system, has also gone abroad.

Max Loewenthal has resigned from the Prometheus Electric Company, of New York, of which he was one of the organizers. The resignation will take effect on September 1.

Trade News

The J. G. Brill Company, of Philadelphia, recently booked an order for thirty-five of its patented semi-convertible cars for the Memphis Street Railway. The cars were ordered through the engineering firm of Ford, Bacon & Davis, of New York City. The semi-convertible system includes the late improvement eliminating the sash trunnions and runways formerly used, and simplifies the method of connecting each pair of sashes. The arrangement is known as the "grooveless post semi-convertible," and has been specified in recent orders from Philadelphia, Boston, Baltimore and elsewhere. The general plan of the lower sash carrying the upper into pockets in the side roofs is preserved. The cars are to be mounted on the builders short-base double trucks, with solid forged side frames, for fast and heavy city and suburban service. They will measure 30 feet 6 inches over the end panels and 42 feet over all. The decks are to be the standard monitor type and the seating plan consists of transverse seats with reversible backs and longitudinal corner seats accommodating four passengers each.

The American Electric Heater Company, of Detroit, Mich., have opened a New York City branch office at 35 Dey street. This is in charge of B. H. Scranton, and will carry in stock a full line of the company's staple devices.

The Risdon-Alcott Turbine Company, of Mount Holly, N. J., have just shipped to the Cramer Electric Company, of Hailey, Idaho, an 800-H. P. turbine unit, consisting of three wheels on horizontal shafts, for setting in a concrete flume. These wheels are to be direct connected to a generator.

The Ingersoll-Rand Company took possession of its new offices on the fourteenth floor of the Bowling Green Building, 11 Broadway, New York, on August 1. At that time the offices of the Ingersoll-Sergeant Drill Company, at 26 Cortlandt street, and the Rand Drill Company, at 128 Broadway, were given up and the united forces moved to the new offices.

The D. T. Williams Valve Company, of Cincinnati, Ohio, announce that they have purchased the exclusive right to manufacture and sell the steam trap and separator and other steam specialties formerly manufactured by the Cookson Steam Specialty Company, of the same city.

Contracts have been let to the Long Arm System Company, of Cleveland, Ohio, for installing its electrically operated bulkhead doors and hatch gears on the United States battleships "Montana" and "South Carolina." The two vessels are now in course of construction by the Newport News Shipbuilding & Dry Dock Company, of Newport News, Va. The Navy Department specifications for these warships provided that "each door must be capable of permitting operation on the spot by power or by hand from either side, and all such doors are to be capable of being closed by power simultaneously from an emergency station." The Long Arm System is the only one that could meet these requirements.

The Lagonda Manufacturing Company, of Springfield, Ohio, has been so crowded with orders that it was necessary for them during the month of July to run their factory all night most of the time. They make tube cleaners and cutters, damper regulators and reseating machines, and also a specialty of contract work for cleaning boilers.

The Chandler & Taylor Company, of Indianapolis, Ind., have recently secured orders for their enclosed, self-oiling, direct-connected engines for Purdue University, at Lafayette, Ind.; the Indiana State Normal School, at Terre Haute, Ind.; the Girl's Industrial School, at Indianapolis, and two units for the Michigan College of Mines, at Houghton, Mich.

The contract for the construction of the United Engineering Building in New York City, which is to accommodate the several engineering societies who have accepted the $1,500,000 building gift of Andrew Carnegie, was awarded recently to Messrs. Wells Bros., of New York, the sum involved being $795,000. This does not include any allowances for the steam heating plant, electric wiring and other details, but relates simply to the general construction of the edifice. The ground is already excavated, and work will begin at once. October, 1906, is mentioned as the probable date of completion and readiness.

It is announced that a consolidation of street car building and allied companies is shortly to be effected. It is probable that G. Martin Brill, president of the J. G. Brill Company, of Philadelphia, will be president of the new company. The preliminary negotiations for the purchase of the different properties were conducted mainly by W. T. Van Brunt—an associate of E. H. Harriman—president of the St. Joseph & Grand Island Railway, and of the Furnaceville Iron Company. The companies to be taken over are: J. G. Brill Company, John Stephenson Company, Laclede Car Company, St. Louis Malleable Casting Company, American Car Company, G. C. Kuhlman Company, Cincinnati Car Company, St. Louis Car Company, Wason Manufacturing Company, Osgood, Bradley & Sons, John J. Cummings Car Company, Jewett Car Company, J. M. Jones' Sons, agents; Laconia Car Company, McGuire-Cummings Manufacturing Company, Peckham Manufacturing Company, Niles Car Manufacturing Company, Journal Bearing Company, Easy Access Door Company.

The Milford Construction Company, Wallace C. Johnson, of Niagara Falls, chief engineer, has closed a contract with James B. Mullen, of Bangor, Me., for constructing its dam and power house. The plant

consists of a concrete dam about 1000 feet long across the Penobscot River, at Oldtown, Me., giving about 25 feet head, and a power house containing twelve 1000-H. P. generators direct connected to water wheels. Water power has been used at this point for several years. About 3500 horse-power are now in use, produced by a wing dam and canal along the west bank of the river. The power produced by the new plant will be transmitted to the city of Bangor, 15 miles away, where a market for all that can be produced by this plant exists.

The Automatic Electric Company, of Chicago, Ill., has been awarded a contract by the Cuban Telephone & Telegraph Company for a 15,000-line automatic telephone system for Havana, Cuba, and a 600-line system for Marianao. The initial installation at Havana will be 5000 lines. Other recent contracts are for a 250-line exchange at Miamisburg, Ohio, for the Montgomery County Telephone Company, and a 1200-line exchange at Aberdeen, S. D., for the Dakota Central Telephone Company. These two exchanges will be the first to have the new automatic four-party lines with selective ringing and lock-out, recently worked out by the Automatic Electric Company's engineers.

The Crane Company, of Chicago, Ill., manufacturers of valves and fittings, celebrated its fiftieth anniversary on July 4. All of the company's branch house managers took part in the celebration. On Monday, July 3, the branch house managers went through the Crane Company's factories. In the evening, at 7 o'clock, they were given a dinner and taken to the "White City," where an evening was spent visiting the various shows. Tuesday morning, July 4, the managers went to Lake Geneva, Wis., where they were entertained by R. T. Crane at his summer residence on that and the following days. Thursday, July 6, the company gave to all its employees and their families a picnic at North Western Park. About 10,000 people attended this. As a souvenir of the anniversary, the company is furnishing to any one in the trade a metal elephant to be used as a paper weight.

The Abner Doble Company, engineers, of San Francisco, have recently secured the contract for the machinery to be installed in an addition to the hydro-electric plant of the Cramer Electric Company, successor to the Idaho Electric Supply Company, at Hailey, Idaho. This contract covers the entire water-power and electrical apparatus, and includes a 400-KW. alternator directly driven by an 800-H. P. set of water wheels, exciter and governor; three-panel marble switchboard; two 25-light arc transformers and 50 arc lamps with regulators, switchboards and other accessories; 14 transformers and other supplies for the distribution system.

New Catalogues

Prospective and present users of chain drives will find something of value in a catalogue on the Renold bush roller chain, manufactured by the Link Belt Engineering Company, of Philadelphia. Notes are given on the choosing and laying out of a chain gear, and its care and lubrication are also dealt with, together with the method of shortening and lengthening it.

Electrical specialties manufactured by the Yost Electric Manufacturing Company, of Toledo, Ohio, are illustrated and described in an attractive pamphlet recently issued. The list includes lamp sockets, rosettes, a wire grip for adjusting a lamp in various positions, a socket handle and cord adjuster, shades, and a double-ended wrench for fixture work.

Primitive and modern methods of driving grinders are shown in a catalogue recently issued by the Northern Electrical Manufacturing Company, of Madison, Wis. A hand-operated Hindu grindstone, requiring two men, and one driven by a dog running inside a large wooden wheel, are the examples of primitive methods, while the company's motor-driven, self-contained and dustproof grinders and buffers show the modern development in this line. Three types of machines are illustrated, for floor, bench and wall use. The parts are illustrated and described in detail, and dimensional diagrams show the sizes of each type. A number of rules are given for keeping silverware well polished by means of the buffers.

A supplement to their regular catalogue was recently sent out by the Trumbull Electric Manufacturing Company, of Plainville, Conn., in which "type A" switches up to 1200 amperes are listed. In adjusting, the blades are ground into the jaws with fine emery, ensuring such a perfect contact, it is claimed, that they will carry a considerable overload continuously without heating. A circular also sent out deals with fuseless rosettes. These are furnished in three styles—cleat, concealed and moulding.

Small springs of every description are dealt with in a catalogue recently sent out by the Wallace Barnes Company, of Bristol, Conn. The illustrations show springs of a wide variety. The pull exerted by flat, coiled and by spiral springs and the set of compression springs are also given.

In a recently issued new steam engine catalogue, the Ball Engine Company, of Erie, Pa., shows several new designs, comprising a side-crank, single-cylinder engine, a tandem-compound, side-crank type, and a cross-compound, side-crank engine. Single-cylinder Corliss engines of both horizontal and vertical types are also illustrated.

Electric headlights for locomotives are illustrated and described in a catalogue sent out by the Pyle-National Electric Headlight Company, of Chicago. Views are given of the equipment on locomotives and instructions are given for installing it. The principal parts of the outfit are fully described, instructions being given for their care and maintenance. A specially advantageous feature is the folded sheet containing diagrams of all the parts, each being numbered and the corresponding names tabulated.

Some idea of the work of J. G. White & Co., of New York, in the construction of interurban railways, may be gained from a pamphlet recently sent out by them. Besides giving illustrations of plants installed and lines equipped, it briefly outlines the work of each department as follows:—The engineering department prepares plans, specifications and estimates on all classes of mechanical, electrical, civil and hydraulic engineering projects; the construction department undertakes the contracts for these; the operating department superintends and operates electric railways, electric light and power plants, gas works, water works and like enterprises; and the financial department gives assistance in financing the construction, equipment or consolidation of steam and electric railways, gas and electric lighting properties and other public utilities. Brief histories are also given of the associated companies comprising J. G. White & Co., Ltd., of London; the Waring-White Building Co., Ltd., of London; and the Canadian White Co., Ltd., of Montreal. The last-named company was recently organized to carry on a general con-

tracting and engineering business, on lines similar to the other companies.

The De Laval Steam Turbine Company, of Trenton, N. J., is treated of with numerous illustrations in a bulletin recently sent out by the company. A short biography, with a portrait, is given of the Swedish inventor, Dr. Carl Gustaf Patrick de Laval. The description of the works makes interesting reading, detailing, as it does, the various processes of building the turbines.

The Demand for Copper

IT has been apparent for many years, says "The Engineering and Mining Journal," that the destiny of our civilization is to be served by electricity—a destiny that in any event cannot be remote. It has been equally apparent that copper (aided somewhat by its colleague and rival, aluminum) must be the carrier of the electric current. The stupendous dimensions of the necessity and opportunity suggested by this observation are matters of daily comment, and yet the conscious genius of trade seems not yet to realize fully the ultimate significance; the market reflects, mainly, a resultant from forces that represent large capital, ambition, foresight—and perpetual timidity.

A remarkable feature of the recent copper production is that no great visible surplus of metal has been accumulated. The increasing demands of electric construction and supply still live in a haphazard way, from hand to mouth. Capital cannot afford to trust the future in supporting the expense of large stock locked up. Meanwhile, the immediate demand continues strong, and among the assuring indications of confidence in the market is the increased dividend of the largest copper combination in the country. Whatever may be the motive which prompted this only partially anticipated generosity, it is safe to say that it would hardly have occurred on a falling market.

There has been considerable inquiry for the "Question Box and Wrinkles" of the Denver meeting of the National Electric Light Association from members who do not wish to wait for the bound volumes of the proceedings, and it has therefore been decided to supply extra copies in paper at a cost of about $1.25 for the two books. They can be had on application to W. C. L. Eglin, secretary of the association, 136 Liberty street, New York City.

Curtis Steam Turbines in Japan

CHARACTERISTIC of the present progressiveness of Japan is the fact that outside of Europe and the United States, this small nation is the largest user of steam turbines in the world.

With the industrial awakening of Japan has come a need for electric power, not only for manufacturing purposes, but also for transportation and lighting. On July 29, 1904, the first shipment of steam turbines arrived in Japan via the steamer "Korea" from San Francisco. They were of 500-KW. capacity, of the Curtis type, built by the General Electric Company, of Schenectady, N. Y., and were for operating the Shigai Railway, in Tokio. Four weeks from their arrival they were in full operation, and have given such satisfaction that thirty-seven Curtis turbo-generators, of more than 35,000-H. P. total normal capacity, were ordered. Of these, eleven units are now installed and in satisfactory operation.

Japan is not slow in adopting the electrical systems which will improve her manufacturing and transportation facilities and give better lighting service. Electricity is in use for operating the street railways of their cities and for indoor and street lighting. In the use of electric power for machine shops, they are following only the best American practice, which, as a rule, requires electric motors mounted on each tool.

The coal mines of Japan will eventually be operated electrically. Some of the turbines mentioned above are intended for the Miike Coal Mines, on the Island of Kyushu. These are owned by Mitsui & Company, and will use two 1000-K. W. Curtis steam turbines.

The Osaka Electric Light Company, which furnishes electricity to the city of Osaka, with a population of over 800,000, is equipped entirely with American electrical apparatus, including six steam turbines of the Curtis type. The capital of this company is 2,400,000 yen, or $1,200,000, and, with its progressive methods, it will soon rival some of the modern American illuminating companies.

One of the largest electrical interests in Japan, which has ordered some of the machinery referred to above, is the Tokio Street Railway Company, which furnishes transportation facilities for the city of Tokio, with a population of 1,440,000. Its Japanese name is Tokio Shigai Tedsuda. Its franchise runs until 1952. Apparently, the municipal ownership idea has obtained some weight in Japan, for this franchise provides that after the year 1932 the municipality may purchase the property of the company by paying a proper price for it. Its capital stock is 15,000,000 yen, or $7,500,000, divided into 300,000 shares.

Although some English and German material is being used by this road, practically all of the electrical equipment is American. This includes five 2000-H. P. Curtis turbo-generator units with power house equipment and railway motors furnished by the General Electric Company; condensers built by the Wheeler Condensing & Engineering Company, of New York, and trucks built by the J. G. Brill Company, of Philadelphia. Besides a small amount of German and English machinery, such as boilers and trucks, there are a few small dynamos which were made in Japan.

A Trolley Light

EVIDENTLY the trolley problem has not been solved yet, for the United States Patent Office, says the "Scientific American," is still crowded with applications for patents on trolley guards, and the like. But a Western inventor has apparently given up the idea that trolley wheels can be made to stick to the wire, and has endeavoured instead merely to alleviate the trouble by providing an electric light near the end of the pole to assist the conductor in replacing the trolley at night. The electric lamp is lighted by a battery located in the body of the car. A switch is interposed in the circuit near the lamp, and to one end of this switch the trolley rope is attached. Normally this switch is held open by a spring; but when the conductor pulls the rope to draw down and replace the trolley, the switch is closed, lighting the lamp, and thereby facilitating the work of placing the wheel in proper contact with the wire. Connected in series with the trolley lamp, are a number of lamps in the car which serve to illumine the same while the trolley is being replaced.

A great advantage of the electric vehicle for commercial use was recently defined by a user of one as follows:—"You can get a $10 per week man to work it from 7 o'clock a. m. to 6 p. m., while you must pay $16 to $25 for a really competent driver for a gasoline vehicle at present, in order to hold him against offers from owners of touring cars."

Light Electric Railways

By JAMES R. CRAVATH

A Paper Read Before the American Institute of Electrical Engineers

ALTHOUGH the building of interurban electric railways has been carried on very actively in the Central States during the last six years, a general survey of the situation shows that the territory served by such roads is rather limited, especially in the States west of Indiana. The typical interurban electric railway of the Central States costs from $20,000 to $25,000 per mile of single track. The building of such roads has therefore been generally confined to such places as in the opinion of the builders have sufficient population and resources to yield an annual gross revenue which will leave from $1200 to $1500 per track-mile to pay interest on the investment after paying operating expenses, maintenance and depreciation. Without going into details, it can be said in a general way that a gross revenue of $3000 to $4000 per track-mile per year must be earned at the start on a most economically constructed interurban road of the ordinary type, if it is to be a financial success.

It has for some time been apparent to engineers that have had to advise regarding numerous proposed interurban electric roads in certain States (of which Illinois and Iowa are the most notable examples) that there is need for a class of electric railway that does not require the heavy investment needed to build the typical interurban road of to-day. In other words, there are scores of places that would not yield an interurban road a gross revenue of $3000 per track-mile per year, and there is little prospect that they ever will; yet half or two-thirds that income would be certain and continuous. On account of the numerous opportunities for roads of a cheaper class in our rich agricultural States, which have comparatively few large manufacturing towns, many engineers have looked forward with much hope to the single-phase alternating-current railway motor as making possible a considerable saving in the cost of construction and operation of these roads. A careful review of recent estimates on cost of construction made by various engineers does not reveal any great possible reduction in first cost by the use of the single-phase electric motor as long as present standards of heavy track construction, heavy rolling stock and high speeds are adhered to.

It is the purpose of this paper to consider whether it is not feasible to work out a new type of light electric railway construction which will involve only about one-third the cost of the typical high-speed interurban road with which we are familiar, which can prosper on a much smaller revenue, and yet fulfil all the transportation requirements of many rural communities. The advent of the single-phase railway motor at least makes such an undertaking appear more promising of success now than in the past.

The first thing to be done in planning such a road is to dismiss the idea of using cars of the weight and operated at the speed required in interurban service, for it would be useless to figure on any material cheapening of the cost of construction, as compared with that of interurban roads, if cars weighing 25 to 30 tons are to be run at speeds of 40 to 50 miles per hour. Of course, first-class, substantial, heavy construction is absolutely essential for interurban service where such construction is to be the basis for operation of cars of the weight and at speeds just mentioned. But the question naturally arises: is it necessary to adhere to such high standards of service and construction for serving all kinds of communities? Why should hamlets and farming townships in Illinois and Iowa, with populations of 100 to 1000, be entirely denied electric railway transportation facilities because they cannot support first-class, high-speed, electric railway service, such as now connect the closely situated manufacturing towns of Indiana and Ohio? In other words, is there any reason for establishing a kind of engineering dead-line, and saying no electric railway outside the cities is worth considering unless it is up to the present interurban standards?

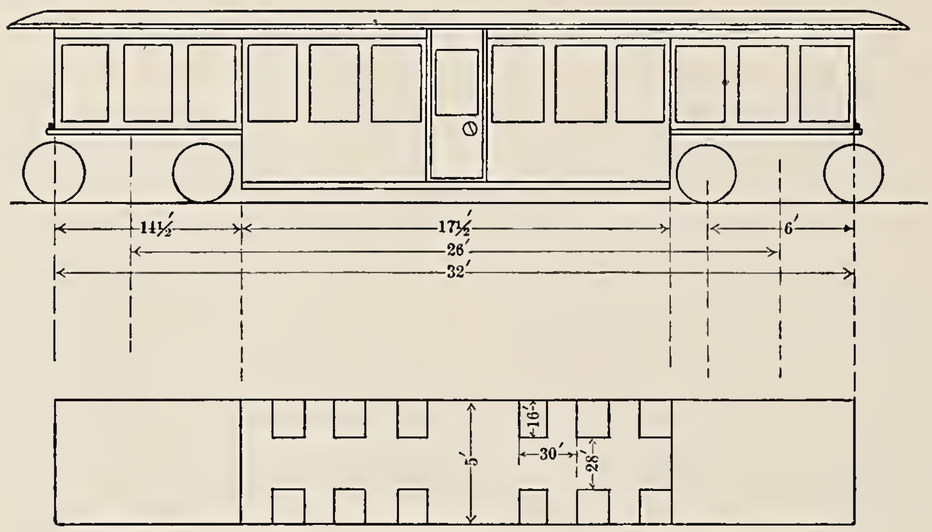
As the character of a road should depend entirely on the character of its rolling stock, consideration will be first given to that feature. It is suggested that on a light electric rural and interurban railway, small double-track cars for a track of about 28-inch gauge might be adopted. Narrow-gauge railways have fallen into disrepute among railway engineers, and with good reason, because the ordinary narrow-gauge road does not differ sufficiently in cost from a standard-gauge road to make the saving worth while in most cases, and also because of the inability to take standard-gauge cars from connecting roads. If we go into the narrow-gauge business we must go far enough to gain some substantial advantage. It is therefore suggested that a road of about 28-inch gauge, although at a disadvantage in not being able to take standard steam-road cars, nevertheless has the decided advantage of a greatly reduced cost of construction.

On a road of the character proposed, maximum speeds of 15 to 20 miles per hour will answer all practical requirements. This speed should be feasible on a roadway of 28-inch gauge, with light double-truck cars of 8 to 10 tons weight. A suggestion as to a suitable form of car construction for such a road, with dimensions, is presented in the outline diagram on the next page. As 28 inches are about one-half standard gauge, no doubt cars of one-half the width of standard-gauge cars could be used with safety. This would permit a passenger car of 5-foot width.

Such a car, if equipped with cross seats, would be of sufficient width for a single seat of 16 to 18 inches width on each side of an aisle 24 to 28 inches wide. Longitudinal seats could be used if preferred. It would not be possible to use the regular plan of placing motor-trucks under the car, because, in order to keep the center of gravity of the car low enough for safety on the narrow gauge, wheels of 16 to 18-inch diameter would have to be used, and it would be impossible to place motors of sufficient capacity on trucks equipped with such wheels. The motor-trucks in this case should therefore be equipped with 30 to 33-inch wheels, which would give abundant

room for motors of sufficient capacity to propel the light cars proposed.

The car floor is made higher at the ends over the motor-trucks than under the balance of the car. If a motor-truck were placed only under one end of the car the trail-truck could have small wheels and be arranged in the common manner. By the arrangement shown the center of gravity will be low, and it leaves a compartment at one or both ends of the car above the motor-trucks, in which can be installed the various electrical appliances that are usually under the car but which cannot be so placed when the car body is hung as low as it is in this case. These compartments can also be occupied by the motorman and used for baggage.



PLAN AND ELEVATION OF A SUGGESTED FORM OF CAR FOR NARROW-GAUGE ELECTRIC RAILWAYS

The car body can be supported by I-beams or channels in the sides of the car just below the windows, and these beams can also support the side sills of the passenger compartment by means of tie-rods and struts. The length of the car may vary considerably, but for very light traffic a car 18 feet long is suggested. This will seat comfortably 12 passengers. Equipped with a motor-truck at one end only, it will probably weigh not more than 10 tons, and with a motor-truck on both ends, 12 tons.

It is assumed that single-phase motors are to be used, which would cause the electrical equipment to weigh more than a direct-current equipment. No such narrow-gauge, single-phase motors have been produced as yet, as far as the writer knows, but undoubtedly could be produced were there need for them. Motor-cars, such as suggested, could haul one or two light freight cars on roads without heavy grades. For a road of this kind trailers would probably best serve to carry freight; and they should be designed so as to allow the freight to be readily transferred to grain elevators or steam road freight cars.

With double-truck motor-cars of the type suggested, a maximum speed of 15 or 20 miles per hour should be safely possible on a 28-inch gauge track with standard T-rails of about 30 pounds per yard. It costs much less to build a 28-inch gauge road laid with 30-pound rails than a road of standard gauge. The tonnage of steel required is half that of a road equipped with 60-pound rails, these being the lightest that it is now considered good practice to use in interurban electric railway work. The cost per ton of light rails is also about 25 per cent. less than that of rails weighing more than 40 pounds. The ties used can be half the standard 8-foot length and less than the usual 6-inch by 8-inch cross section.

The cost of grading would be reduced from standard-gauge construction for the two following reasons: first, the reduction of the cross section of cuts and fills by the narrowing of the embankment; secondly, with a road of this kind operating at slow speeds on a narrow gauge, it would be good engineering to avoid many of the cuts and fills that would be necessary on a high-speed road, and to pick a location which goes round hills rather than through them. The rolling prairie country of the Central States would almost invariably permit the location of the route of such a light railway so as to be almost free from all heavy grading work. What would be considered a very crooked route for a standard-gauge steam road would be unobjectionable on a light railway of this kind. By laying out the road so as to avoid heavy grading work, the expense of bridges and trestles would also be reduced to a minimum. In crossing large streams, of course, approaches and bridges must be built which are out of the way of floods, but large streams are the exception, and probably the majority of light railways of this class would not cross any large streams unless on a highway.

The next question is that of ballast. Since many branch steam lines and some interurban electric lines are still operating without ballast, it would hardly seem wise to invest much money in ballast for a light railway of this kind. Ballast is desirable, to be sure, but in this case the expense would hardly be justified.

The overhead trolley construction should be simple in character, since it will have but light traffic passing under it. By using single-phase, alternating-current motors with a trolley pressure of 3000 to 4000 volts, feeders will not be needed to supplement the trolley on a rural road 20 miles long with power supply from one end. The trolley wire itself can be No. 0 wire. The poles will therefore need to be heavy enough to support the trolley-wire bracket only. It is assumed that the catenary construction would be used with the trolley wire, supported at frequent intervals by a steel catenary, the latter resting in turn upon center-bearing, high-pressure insulators. Instead of a costly iron bracket for supporting the trolley, a bracket consisting of a 5-foot wooden cross-arm, supported from above by a tie-rod and bolted to the pole at one end, would answer the purpose.

In most cases power could be purchased from a light and power company at the principal terminus of a line, thus keeping the cost of power within reasonable limits, as the amount of power required would not justify a separate power house. It is assumed that the railway company would furnish a generator, this generator to be placed in the lighting company's station, the balance of the power investment to be made by the lighting company.

The following estimates are on the cost per mile of a railway built according to the foregoing ideas; these estimates are, of course, conjectural, as no such road has ever been built. The figures are based on cost of present railway construction, assuming all the supplies and rolling stock to be standard:—

COST OF ROAD AND EQUIPMENT PER MILE

TRACK AND GRADING

Right of way donated.	
Grading averaging 7000 cubic yards per mile, at 18 cents per cubic yard	$1,260
30-pound T-rail, at $33 per ton, 52.8 tons, 30-foot lengths	1,742
352 rail-joints, at 75 cents each	264

2640 ties, 4 inches by 6 inches by 4 feet, at 20 cents each	528
30 kegs spikes, at $3	90
360 bonds, at 30 cents each, in place	108
Labour, laying track	300
Highway crossings	25
Fencing (20 miles)	150
Track total	$4,467

GENERAL ROADWAY ITEMS FOR 15-MILE ROAD

Culverts, etc.	$1,500
Bridges	1,000
Special work	2,000
	$4,500
Per mile	300

OVERHEAD LINE PER MILE

48 poles (25-foot), at $4	$192
Wood brackets (cross-arm size), 3.5 inches by 4.5 inches by 60 inches, at 50 cents	24
48 high-pressure insulators, at 15 cents	8
5280 feet No. 0 trolley wire, at 15 cents per pound	253
5280 feet 0.25-inch steel stranded catenary, 65 cents per foot	34
528 clips and catenary attachments, at 20 cents	106
Miscellaneous overhead supplies	50
Labour on trolley and catenary	150
48 cross-arm tie-supports, at 15 cents	7
Telephone wire, 2 miles, No. 8	30
Telephone insulators and brackets	10
Labour on telephone line	25
	$889

ROLLING STOCK, BUILDINGS, ETC., FOR 15-MILE LINE

3 passenger motor cars, at $2500	$7,500
2 passenger trailers, at $750	1,500
1 freight motor car	2,200
15 miscellaneous freight cars, at $300	4,500
Car house and repair shop	2,000
100-KW. generator capacity in lighting station	2,000
Miscellaneous engineering and superintendence	15,000
Total for 15 miles	$34,700
Per track mile	2,313

RECAPITULATION COST PER TRACK MILE

Track and roadbed	$4,467
General roadway items	300
Overhead work	889
Rolling stock, buildings, and miscellaneous	2,313
Total per mile of track	$7,969

The estimates are believed to be fairly liberal for the class of construction proposed. The total amounts to about $7900 per mile of track, or a little over one-third of the cost of a standard-gauge high-speed road.

The next question to determine is whether a road of this kind is capable of earning enough to pay interest on the investment. Assume the road to be 15 miles long. A good passenger and freight service for a rural community could be given by a daily schedule calling for the equivalent of 15 round trips of trains consisting of motor-cars, hauling freight cars whenever necessary. On a 15-mile road this would mean 450 train-miles per day, or say 135,000 train-miles per year, allowing for some reduction from foregoing schedule during the winter.

The following is believed to be a fair estimate of the ordinary operating expenses per train-mile of such a road:—

Power per train mile, 1 KW.-hour, at 3 cents (purchased)	$0.03
Motormen's wages	0.025
Repairs and maintenance on rolling stock	0.005
Repairs and maintenance on track and overhead line	0.01
General expenses	0.015
	$0.085

135,000 train-miles per year, at $0.085	$11,475
Cost of operation per track-mile ($11,475 ÷ 15 miles)	765
Interest at 6 per cent. on $7900 per mile cost construction	474
Interest and operating expenses per track-mile	$1,239

Obviously, there are plenty of locations where a road could easily earn this, and in addition enough to cover depreciation. In these locations standard-gauge high-speed roads would be prohibited by financial considerations.

Without doubt difficulties stand in the way of the construction of the first roads of this class that may be built. One of the most serious obstacles is that no cars, motors, trucks or overhead work suitable for such a road are now being manufactured; and before such roads can be built these must be developed, either by the manufacturers or by the prospective user. It is not to be expected that the manufacture of light electric railway apparatus will be attempted until there is a wide enough interest in and demand for railways of this kind to induce manufacturing companies to develop and market suitable equipments.

RURAL PASSENGER AND FREIGHT TRAFFIC

Supplementary to the engineering and construction matters considered in the foregoing part of this paper, tentative estimates have been compiled by the author on the traffic possibilities of a strictly rural territory. Light railways of this class need not necessarily be confined to strictly rural business, as doubtless most of them would serve small towns as well as the intervening country. However, in a rich agricultural State where the chief industry is farming, the revenue from the farmers is the first thing to be considered.

In the United Statese census of 1900 the annual value of farm products in three of our richest agricultural States is given as follows:—

	Per Square Mile
Iowa	$6,630
Illinois	6,180
Indiana	5,700

In Iowa 40 bushels per acre is considered the average corn crop. If this brought 35 cents per bushel, the yield per square mile would have a value of $8960, but of course this amount would not be shipped. If $7000 worth were shipped, it is fair to assume that the local rural railway would be able to get a price equal to 1 per cent. of the value of the shipment, or $70 per square mile.

Rough estimates obtained from the owners of six ordinary farms located in Central Iowa result in the following average estimates of the amount of farm products shipped. The total area of these farms was 1513 acres, and the amount of live stock shipped 470,000 pounds, or 295 pounds per acre. The grain hauled to town from these farms amounted to only 7095 bushels, or 4.7 bushels per acre, as that part of the country has practically abandoned grain shipment and gone into the stock-raising business. The tonnage of coal hauled from town to these farms averaged 8.1 tons per square mile.

Take as a basis the figures from the six farms before mentioned, and suppose that the live stock is worth 4 cents per pound. With 295 pounds per acre the value of live stock would be $11.80 per acre. Assuming the 4.7 bushels of grain per acre to be oats (as most of it was) at 25 cents per bushel, the value would be $1.17 per acre which, added to the live stock, makes a total of $12.96 per acre, or $8300 per square mile for the value of the products shipped. If 1 per cent. of this could be obtained for the local freight rate, it would give the road a revenue of $83 per square mile of tributary territory. Estimating on a tonnage basis, the revenue from hauling the same products would be as follows:—

94 tons live stock, at 50 cents per ton	$47
8.1 tons coal, at 50 cents per ton	4
3000 bushels of grain, at 1 cent per bushel	30
Total freight revenue per square mile	$81

It will be seen that all these estimates correspond in ultimate results: this leads one to believe that they are not unreasonable. Now consider these estimates in the light of the probable earnings of a strictly rural electric railway.

For this purpose assume that a road is to extend from a good-sized county seat 15 miles into a country which has no railroad stations nearer than the county seat. The tributary territory to such a road may be estimated to be 106 square miles by the following process of reasoning:—For the first 3 miles out of the terminal no tributary territory is considered, although of course there should be considerable passenger and light freight business from this portion of the road. For the remaining 12 miles of the road the tributary territory is estimated as follows:—

	Square Miles
Fourth mile of track, 1 mile on each side	2
Fifth mile of track, 3 miles on each side	6
Sixth mile of track, 4 miles on each side	8
Seventh to 15th miles, inclusive, 5 miles on each side	90
Total tributary territory	106

While a territory extending 5 miles each side of the track may not seem a conservative estimate at first, it must be remembered that traffic will naturally seek the nearest railroad; and in this case it is assumed that

there are no other railroad stations as near to the territory served.

The possible gross revenue from freight has already been estimated to be between $70 and $83 per square mile. Taking the lowest figure, $70, the revenue from 106 square miles would be $7420, or $494 per track-mile.

Assume that a prosperous rural community yields $10 per year per capita in passenger revenue—not an unreasonable assumption when one considers that the estimated earnings of interurban lines between large towns include a large population which does not ride and is not dependent on the interurban road. Assume a rural population of 10 per square mile. A territory of 106 square miles, with 10 persons per square mile, makes a total of 1060 population, and $10 per capita per year for this population is $10,600, or $706 per mile of track for the rural population.

Suppose that the road has at about 10 miles from its terminus a town of 1000 inhabitants. These should yield a revenue of $5 per capita per annum or a total of $5000. This is equivalent to $333 per mile of track.

EARNINGS AND OPERATING EXPENSES PER TRACK-MILE: SUMMARIZED

Passenger earnings (rural)	$706
Village passenger earnings	333
Freight earnings, lowest estimate	494
Mail and light express	100
Total gross earnings	$1,633
Operating expenses	765
Net	$868
Interest on investment	474
Surplus	$394

Considering better railway transportation as one solution of the good roads problem in the Middle West, and the number of places demanding light electric railways, it is important that the attention of the public, of electric railway engineers, and of the manufacturers of electric railway apparatus, be centered on the light electric railway problem. From the manufacturing standpoint it opens an immense field for this kind of railway equipment, while from the farmer's standpoint the increase in the value of farms served by such a road would ultimately pay for its construction.

The Colorado Electric Light, Power and Railway Association will hold its third annual convention at Glenwood Springs, Col., September 18, 19 and 20, 1905.

Cairo, in Egypt, now has about 26 miles of electric railway in operation with a steadily increasing traffic.

Electrical Features of the Recent Elks Carnival at Buffalo

During the week commencing July 10 the entire business part of Buffalo was in gala attire in honor of the nineteenth reunion of the Order of Elks. Bunting of many colors—purple, the Elks' color, predominating—was draped everywhere. The daylight scene was gorgeous, but was far excelled by the electrical decorations, which literally turned the night into day.

Through the energy and resourcefulness of General Manager Charles R. Huntley, of the Buffalo General Electric Company, the city streets presented a night scene of splendor probably never before equaled in similar celebrations. Niagara electric power was freely drawn upon, and was everywhere in evidence through incandescent lamps festooned across the fronts of buildings in "welcome" signs and in elaborate special designs embodying the characteristic Elk emblems.

A DAYLIGHT VIEW OF THE MERCURY ARC TOWER USED DURING THE ELKS CARNIVAL AT BUFFALO

The unique feature of this festival of light was a "Mercury Arc Tower" located in Shelton Square. This was a fluted column of "staff" 75 feet high, studded with 100 mercury-arc lamps. Standing alone, this tower produced a most startling effect, due largely to the characteristic greenish light of the mercury-arc lamps. It stood out conspicuously in the mass of many-coloured incandescents covering the fronts of the buildings on the square and the radiating streets. The natural curiosity of the people regarding its peculiar colour caused a constant jam about its base. Inasmuch as the tower was visible for a long distance up the streets leading from the square, it received a great deal of attention, and was freely spoken of as the most original feature of the carnival.

The mercury-arc lamps were operated in two series of 50 lights each from 4-ampere Brush arc machines located in the Wilkinson street station. As each lamp consumes only 160 watts, the operating expense was extremely low for so brilliant a spectacle. They were of the standard type for outdoor lighting, as developed under the direction of Dr. Steinmetz and manufactured by the General Electric Company.

This new use of the mercury-arc lamp on a large scale marks a radical step in electric lighting for decorative

purposes. The incandescent lamp reached its climax for general illumination and for decorative effects at the Pan-American Exposition four years ago in Buffalo, and it is interesting to note that the latest development in this branch of the art was successfully tried in the same city and with Niagara power also.

This luminous tower was a special contribution to the carnival by the Niagara Power Company, the Cataract Power & Conduit Company and the Buffalo General Electric Company. Mr. Huntley conceived the idea, and designs were prepared by the illuminating engineers of the General Electric Company, which furnished the material and superintended the installation. The most elaborate decorative feature utilizing incandescent lamps was located at the corner of Main and Seneca streets. This was a regular cob-web of wires studded with incandescent lamps of various candle-powers, the whole structure being crowned with four massive elks facing the four points of the compass. Four thousand lamps were used in this one feature.

Many of the business houses of Buffalo employed experts to decorate the fronts of their buildings, and the results were decidedly pleasing. Many stores increased their window lighting or added new signs, which will remain permanently. Thus, the celebration not only increased to a very large extent the temporary lighting of the local company, but added not a little to its permanent load.

NIGHT SCENE AT THE ELKS CARNIVAL IN BUFFALO, SHOWING THE TOWER ON WHICH 100 MERCURY ARC LAMPS WERE PLACED

According to Professor William Kent, of Syracuse University, there is apparently no limit to the future demand for young engineers. It will vary somewhat from one year to another, according to the financial condition of the country in these years. In years of prosperity nearly every graduate of an engineering college of the first rank obtains a position immediately upon graduation. In dull years perhaps only one-half of the graduates will be located at once, but the remainder usually find their jobs within a few months. If there is any limit to the number of graduates that the country can absorb, it is not yet in sight.

Wireless telegraphy was recently on the variety stage in London. At the Empire Theatre illustrations were given of the use of the Marconi system for various purposes.

Gas Engines for Long-Distance Power Transmission

THE very rapid progress in the development of electrical machinery and appliances during the past ten years, said John Martin, in a paper recently read before the Pacific Coast Gas Association, has invited the capitalist and engineer to install and operate many hundred thousand horse-power, utilizing the waters of the various streams, as a source for generating the current. The prime incentive for such development from the investor's standpoint was the fact that the source of power was being constantly renewed by the laws of nature, and with the authentic records of precipitation as a guide, the prudent engineer has recommended a great many plants to be constructed, which have proven financially and commercially successful.

The most notable examples of this progress have been, and are being, developed in the State of California. A great many surprises of a practical nature have been encountered by the managers of these various water power electric developments with particular reference to earning capacity, and more particularly with reference to the relation of "plant utility to plant capacity," commonly termed "load factor." The manager is constantly trying to find ways and means of utilizing the electric current during such times of the day or night when his present consumers do not require it. Numerous plans and devices have been utilized to further this end.

Within the past year the problem was presented to the officers of the California Gas & Electric Corporation, who were desirous of furnishing all the electric current for the operation of the street railroads under the control of the United Railroads of San Francisco, and negotiations were commenced with the officers of the latter company, with that end in view. It was very difficult for the railroad people at first to develop even a hope that such a condition of affairs could be made feasible. Here was a company with its thousands of horse-power developed at no point nearer than 140 miles from the proposed place of consumption, and while it is true that this company has many sources of supply, and many avenues of delivery, yet there was an insurmountable barrier in the minds of the railroad people as to the advisability of purchasing current at any price if the convenience of its patrons was to be sacrificed in any way.

As one of the officers of the railroad company remarked, "We certainly desire to save money in the operation of our property—within reason—but at the same time we care more for the good will and satisfaction of our patrons; and if any interruption of service should occur on all your lines feeding into this city at one time, we cannot expect our citizens to be patient while sitting in the cars for an hour and a half, until you get up steam." The railroads are operating their steam plant for this service, and the power company suggested the continuance of the operation of these steam plants, and receiving a portion of the power from the power company, but this plan was not considered advisable.

After numerous interviews with an honest desire on both sides to try and accomplish the economic result, if it could be done without sacrificing the interests of the patrons of the railroad company, a firm conclusion was reached that in a service so large and important as the carrying of hundreds of thousands of people daily in a large city, nothing could be done on the plans outlined, unless some absolute guarantee of continuity of service were available, and it certainly was not favourable from the standpoint of the utilization of steam engines for emergency purposes, because if steam were being maintained constantly under the boilers, no economy could result, and if the plants were allowed to cool off, the time element of starting would prohibit their use. The officers of the power company had been making thorough investigations of the development of the gas engine in large units, having sent two of their engineers throughout the entire East to make full and complete reports. In consequence, and as a last resort, the power company agreed to install three gas-engine electric generating units, each unit having a capacity of 4000 KW., or a total initial capacity of 12,000 KW. This plant will be enlarged as rapidly as the requirements of the railroad may demand.

The guarantees which have been made by the manufacturers of these engines are particularly interesting, and if successful will undoubtedly place long-distance electric transmission in a position to practically guarantee continuous service, regardless of the length of its transmission lines or the momentary interruptions which do occur through causes beyond human control.

It might be fairly stated that the gas engine stands alone as the only means of instantaneous generation of electric current at distributing centers in times of emergency, at any fair or reasonable cost. The gas engine electric generating plant of the California Gas & Electric Corporation will also be utilized to a certain extent for the purpose of increasing the load factor of the transmission line, for it is obvious to those familiar with power transmission plants that after proper installations have been made, including full capacity at the hydraulic end, as well as in the power house, and in pole lines, there is absolutely no increased cost for current to the power company, whether its load factor be 0.2 or 0.99, and any device which can be utilized to improve that load factor adds that much income and net profit for the power plant. In this particular case the gas engine generating plant was a necessity, without which the California Gas & Electric Corporation would have been unable to have obtained the contract for power. That being the case, the officers decided to make a virtue out of this necessity, and up to the extent of the cost of fuel being less than the increased value derived from improving the load factor on the power lines, they propose to operate this gas engine plant in that manner and for that purpose.

The gas which will be used to drive these engines will be manufactured from crude oil, and will be of the quality similar to the illuminating gas now being distributed throughout the State of California, manufactured by this process, ranging from 610 to 660 B. T. U. per cubic foot.

Nearly all of the gas engines in use throughout the East and Europe are utilizing producer gas or blast furnace gases, except in very small units, or where natural gas can be obtained, and from investigations which Mr. Martin made, he ascertained that the largest gas engine using manufactured gas of more than 600 B. T. U. has a rated capacity of 300 H. P., while those in process of installation near San Francisco will, in each case, be more than seventeen times as large. The nearest approach to these large engines in size are two, which are in operation at Hastings, W. Va., each having 4500-H. P. capacity, and driven by natural gas, being used for the compression of natural gas for transmission through a pipe line 200 miles in length. These engines have been, and can be, started from cold and rest to full load in less than 60 seconds.

These gas engines are now being built by the Snow Steam Pump Works, of Buffalo, N. Y., and in general design and detail resemble very closely a modern high-grade, massive American steam power engine. They are of the horizontal, twin tandem, double-acting, four-cycle type, giving two impulses to each crank per revolution. This is equivalent to a cross-compound steam engine.

The dimensions of these engines are very interesting:—Length over all, 70 feet; width over all, 34 feet; weight of heaviest casting, 60 tons; diameters of cylinders, 42 inches; length of stroke, 60 inches; main journals, 30 inches diameter, 54 inches long; main cross head gibs, 27 inches wide, 54 inches long; diameter of center of shaft, 38 inches; weight of fly-wheel, 130,000 pounds; total weight of engine, fly-wheel and generator, 1,200,000 pounds.

These engines will probably be in operation on or before January 1, 1906, and from all the investigations which have been made, there is no doubt as to the absolute success of this installation when completed.

An Oxygen-Generating Product of the Electric Furnace

In a recent address on "The Electrochemical Industries of Niagara Falls," before the American Chemical Society, F. A. J. Fitzgerald said that sodium peroxide is now made in the form of blocks in the electric furnace so as to be used in generating oxygen, much as calcium carbide is used to generate acetylene gas.

Oxone, as this new material is called, is prepared in square blocks, each weighing 70 grams (about 2.4 ounces), for generating oxygen in stereopticon work. It is also the intention of the manufacturers, the Roessler & Hasslacher Chemical Company, of New York, to furnish oxone in round cakes weighing about 180 grams. One of these in water will generate pure oxygen, 1 pound yielding 2.08 cubic feet of gas.

A sensitive fire alarm which has been brought out by a Danish inventor only acts when a sudden wave of heat is generated. A U-tube, 4 inches high, is filled with mercury, the upper parts containing sulphuric ether, and both ends being closed. One side of the tube is covered with a non-conducting material. An even and gradual rise of temperature warms the entire apparatus, but a sudden heat, as in fire, vaporizes the ether under the unprotected glass, forcing down the mercury, and ringing an electric bell by the closing of a local contact.

THE ELECTRICAL AGE

Established 1883

Volume XXXV Number 3
$2.50 a year; 25 cents a copy

New York, September, 1905

The Electrical Age Co.
New York and London

Building an Electric Railway in the Philippines

By PERCIVAL E. FANSLER, E.E.

OLD STEAM LOCOMOTIVE AND DOUBLE-DECK CAR ON THE MALABIN TRAMWAY

SO rapidly are the more densely populated sections of the United States being covered with a network of electric railways, that the completion of such a system is usually a matter of only local interest. In relatively rare instances, in which new and important engineering features have been incorporated in the design, or where extraordinary engineering feats have been accomplished, the matter attracts greater attention. In other words, each interurban railway built in the United States is to all intents and purposes precisely like the many others under construction at the same time, and the problems confronting the engineer in charge of such work are almost identical with those which he is called upon to solve time and time again.

When, however, a project of this character is to be carried out in a land nearly half-way around the globe, peopled by a race partially civilized, but wholly unacquainted with American methods of construction, it must needs be a man of high engineering attainments and unlimited resources who can successfully cope with the totally new and often unexpected conditions that arise.

When, three years ago, a number of American capitalists, headed by the engineering firm of J. G. White & Co., of New York, made an investigation of the feasibility of financially invading the Philippines, conditions were so unfavourable as to excite comment on the daring of the men in question. At that time, Manila, the capital and chief city of the Philippines, was filled with American troops, and skirmishes with the natives were common even in the outskirts of the city. The invasion of American capital at a time when the city was not yet in full accord with the ideas of the United States Government, and when the island was in open revolt, was looked upon as rash in the extreme, and it was only with full confidence in the home government and in the future developments of the island that the decision to take over and consolidate some of the most important public utilities in Manila was made. The plan contemplated primarily the electrification of the old mule traction system that had been operated for a number of years by a Spanish company, but which was totally inadequate to handle the comparatively large traffic then existing.

To carry out this project, it was practically necessary to rebuild all of the track, as the light rails which served the diminutive cars were entirely too light for the heavy electric cars to be introduced. A secondary project contemplated the consolidation of the existing electric lighting company, and the replacing of the

FILIPINOS UNLOADING GRAVEL. CHARACTERISTIC NATIVE METHOD OF CARRYING EVERYTHING ON THE SHOULDERS. SEE PAGE 164

RECLAIMING GROUND ON ISLA DE PROZISARA ON WHICH THE POWER STATION IS LOCATED

EXCAVATING FOR THE LINE IN THE STREETS OF MANILA

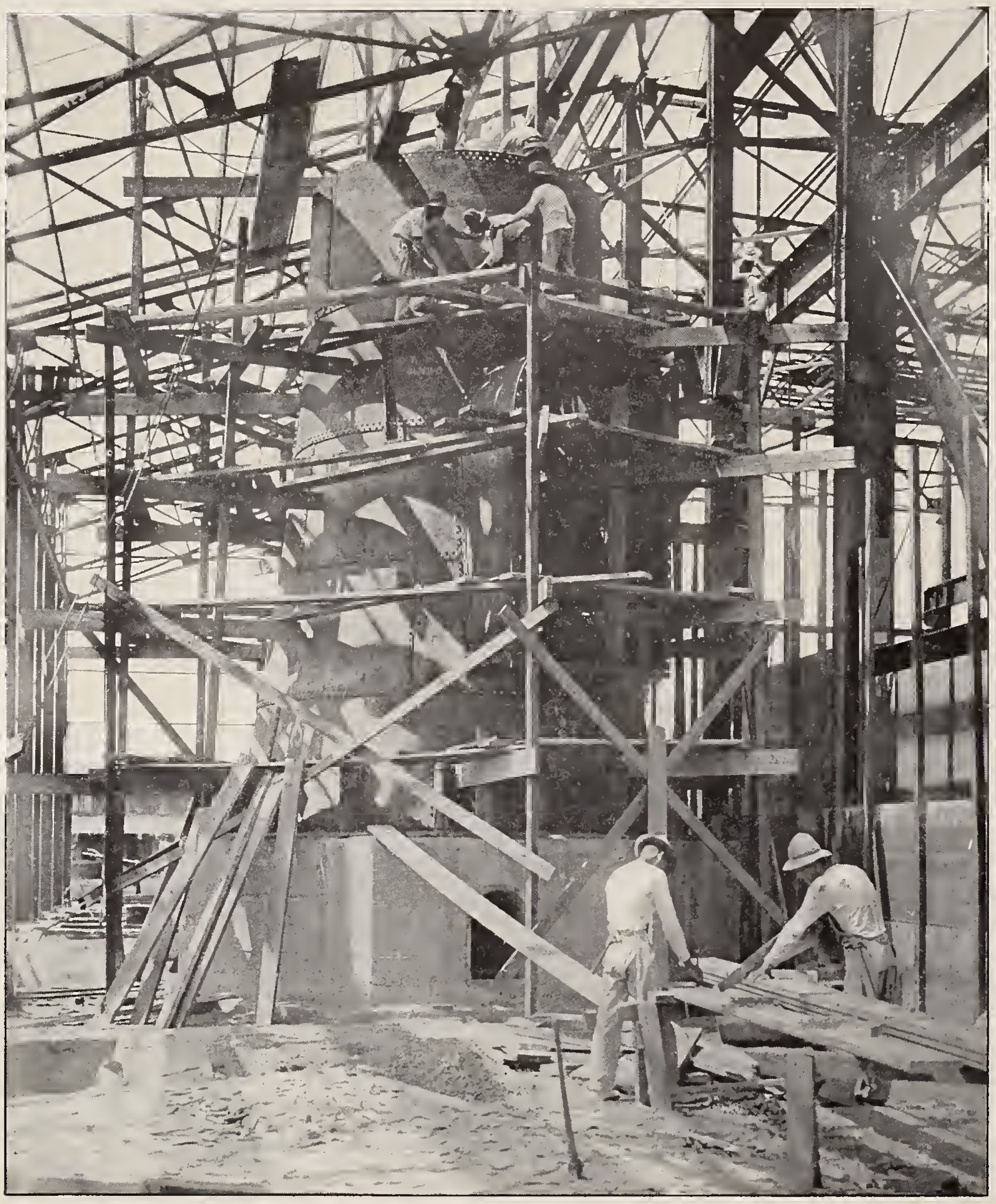
out-of-date power plant by large and efficient units, located in the new power station of the street railway system. In other words, this group of American capitalists, with characteristic insight into the future, invaded Manila when it was on the firing line, with the intention of providing, when the confidence of the Filipinos, and consequent stability of trade, had been established, public utilities that would stamp Manila with the earmarks of the industrial center she has become, and at the same time serve as a stimulus to the enterprise of the native population, which had been so long held in check under Spanish rule.

C. G. Young, one of the engineers of J. G. White & Co., was sent to Manila to investigate as to the feasibility of the project as outlined, and upon his return and presentation of a favourable and enthusiastic report, the machinery of the organization was set in motion, with the result that on April 10, 1905, the electric railway system of Manila was formally opened with impressive ceremonies in which the civil authorities joined.

To one unfamiliar with the peculiar conditions that existed in Manila three years ago, it is difficult to appreciate the gigantic task imposed upon Harry A. Belden, who was sent to Manila by J. G. White & Co., to take charge of the work. It was not only a question of physical labour; the moral problems were perhaps more difficult of solution than any of the mechanical obstacles which had to be overcome.

For some time, while the preliminary surveying was being carried out, the momentous question was,—Can Filipino labour be successfully employed? Under Spanish rule it had been a common occurrence for the Spaniards and other aliens to employ natives for certain work, and then either refuse payment, or pay out only a small part of what was due. In this the natives had practically no redress, as the influence of the Spaniards in their own courts made it impossible for the natives to secure justice. This procedure had become so usual that, when Mr. Belden first endeavoured to secure labour, he found that the natives either would not work at all, or only upon prepayment for the day's labour. The full reserve of tact possessed by the American foremen was called into play, as it soon developed that the real trouble lay in the belief of the Filipino that he would not receive his pay. By means of interpreters the American methods were explained; still the men could not be induced to work for even a single day, and the suggestion that they wait until the end of the week for their pay was met with laughter.

Finally a solution was arrived at through the discovery of a large number of brass tool-room checks, stamped with the letter J. G. W. & Co. These were paid out to the natives in the morning. Upon their receipt work was started, and although some trouble was experienced during the first week or two, the natives set to work with a vim as soon as they found that they were being fairly treated. The difficulty



THE BASE OF THE POWER HOUSE CHIMNEY, SHOWING THE ENTRANCE OF THE BOILER FLUE

of the situation can well be imagined. Each foreman supervised the work of from 50 to 80 Filipinos, speaking half a dozen different dialects, totally unfamiliar with tools of any kind, save the universal machete, and unable to receive instructions except through an interpreter.

The first thing in order was to school them in the use of such elementary tools as the shovel, pick, crowbar, axe, and wheelbarrow. Strange as it may seem, it was almost impossible at the start to induce a native to use a shovel. He much preferred squatting on the ground and using his hands, or standing and moving the earth with his feet. Even after working a year or more, if a native was spoken to sharply and thrown into confusion, he would drop his pick or shovel and resort to primitive methods.

For centuries Filipinos had carried comparatively large articles on the head or shoulders, and it was difficult to get them to use a wheelbarrow. In many instances a workman would load a barrow with gravel or stone, and then lift it to his shoulders and proceed to his destination. Illustrating this point, it might be said that gravel was obtained from the bed of the Pasig River, above Manila. The natives would load their frail canoes or "bancos" with their hands, and upon arrival at the site of the power station, would with the same utensils fill small baskets, which were carried ashore on the shoulders, as shown on page 161.

Considerable difficulty was experienced in teaching them to use the long-handled shovels when digging holes for trolley poles. In setting the poles, they found it awkward to use pike poles, and often, when the butt of a pole had been slipped into a hole, they would drop the pike poles and try to settle the pole with their hands. The natives are unsuited for this class of work on account of their small stature.

Their natural agility and ability to climb led them to discard the climbers used in the United States; barefooted, the native would literally walk up a pole as easily as an American lineman with spikes. When it came to stringing the trolley and feeder wires, their superstition got the better of them; having been told that the wire was "what would make the car go," they were at first chary of handling it.

The Filipinos were at their best as carpenters, for which trade they seemed to have a natural inclination. Supply a native with a pile of bamboo and a machete, and he will construct a house and furnish it complete in a way that would shame his white brothers with many more tools at their disposal. Astonishing as it may seem, the natives were quick to grasp the details of steel construction, and all of the riveting and allied work on the steel framework of the large power house, car shops, and barns, was done by them.

It is interesting in connection with this to note that the company expects in the future to build all of its own car bodies in the shops and to employ almost exclusively native labour. One characteristic of the native is that he learns largely by imitation. He will watch his foreman go through a certain operation, and with a little practice is soon able to do the same thing in a very satisfactory manner. However, if he is taken from this work and taught a new operation, it is more than likely that he will forget how to do the first job.

In view of the above, it will be seen that Mr. Belden accomplished a remarkable feat in his adaptation of the Filipino workman for what, in some instances, might be termed high-grade labour in the United States, and it was a matter of editorial comment that the organization engaged in the construction work was the first to successfully employ natives on a large scale. As it is difficult for one in the United States to understand and appreciate conditions in the Far East without personal contact, the following editorial from "The Manila Cable News," of April 11, 1905, is quoted, as it voices the local sentiment:—

"The completion of the construction of the electric car line marks an important date in the history of American occupation of the Philippines, and is a splendid testimonial to the enterprise and perseverance of the men who have directed the undertaking. No one who has not had experience in such work can understand the difficulties of getting together a complete equipment from all

over the world and installing all the necessary adjuncts to the successful operation of a great plant of 50 miles of street railway with 100 cars in operation.

"All this and much more has been accomplished promptly and without change of plan of management since the inception of the enterprise. It is also notable that the work of construction has been nearly all done with native labour, and that the company declares such labour to be profitable and satisfactory. The inauguration of the line with Filipino conductors and the proposed installation of native motormen as soon as men can be trained, is a further evidence of the good results of the company's experiments with the Manila labour problem.

THE POWER HOUSE. THE TOWER AT THE LEFT SUPPORTS THE LONG-SPAN CABLES OVER THE PAS'G RIVER

"The value of an extensive modern electric car line to this city can hardly be overestimated. Manila is a city of long distances, and one of the most vexing problems of life here has been that of getting about the place. Our heretofore methods of public travel have been either very expensive or abominably bad; and between the two most people have been compelled to maintain a small livery stable at large expense. The cochero, public and private, has been the tyrant of life in Manila, but today marks the end of his career.

"Not the least of the good results of this system will be the social leveling of all classes and conditions of people. When one's standing is judged by the sort of carriage in which one

THE POWER HOUSE CONTAINS THREE 1000-H. P. WESTINGHOUSE-PARSONS STEAM TURBINE GENERATORS AND ONE OF 2000 H. P.

THE HIGH-TENSION LINE ENTERING THE POWER HOUSE

rides, all sorts of petty and unwholesome distinctions arise, and a tendency to arrogance and exclusiveness is developed which is detrimental to the public spirit of a progressive people. The car line will do much to keep us all on the ground together.

"Some of us who have known little of the almost insuperable difficulties in the way of successfully completing such an enterprise, have wondered why the cars were so long in starting. The fact is that under the circumstances good time has been made. Comparison with other Oriental cities will show Manila now to be far in advance of Hong Kong, Singapore and many others whose work of street railway building began before Dewey ever dreamed of coming to Manila. It is now up to every man with a spark of public spirit in him to patronize the car line and set the example that will make the new system popular at once.

"Congratulations, then, to the management of the Manila Electric Railroad Company on the splendid work wrought. Congratulations to the city of Manila, and congratulations to all of us who can now get about the town cheaply and promptly and (dear to the American) independently."

Coming now to a consideration of the physical conditions of the public utilities in Manila, which form the subject of this article, we find that for many years the sole means of transportation were the mule car system known as La Compania de las Tranvias de Filipinas, and the public horse vehicles known as carromatas, quitez, and calesas. It is significant that in 1902 nearly 10,000 public vehicles were licensed to carry passengers, in itself an indication of a large and scattered population depending upon an antiquated tramway system. It was estimated that over $4,000,000 (Mexican) were collected from the public passenger vehicles per annum. Again, the inadequacy of the local utilities made it necessary for the government to maintain a large number of official cabs for use by public officials during business hours. The government is now able to dispense with a large number of these cabs at a considerable saving.

The old horse line was divided into a number of sections over which a 2-cent fare was charged. No definite schedule was maintained, and the

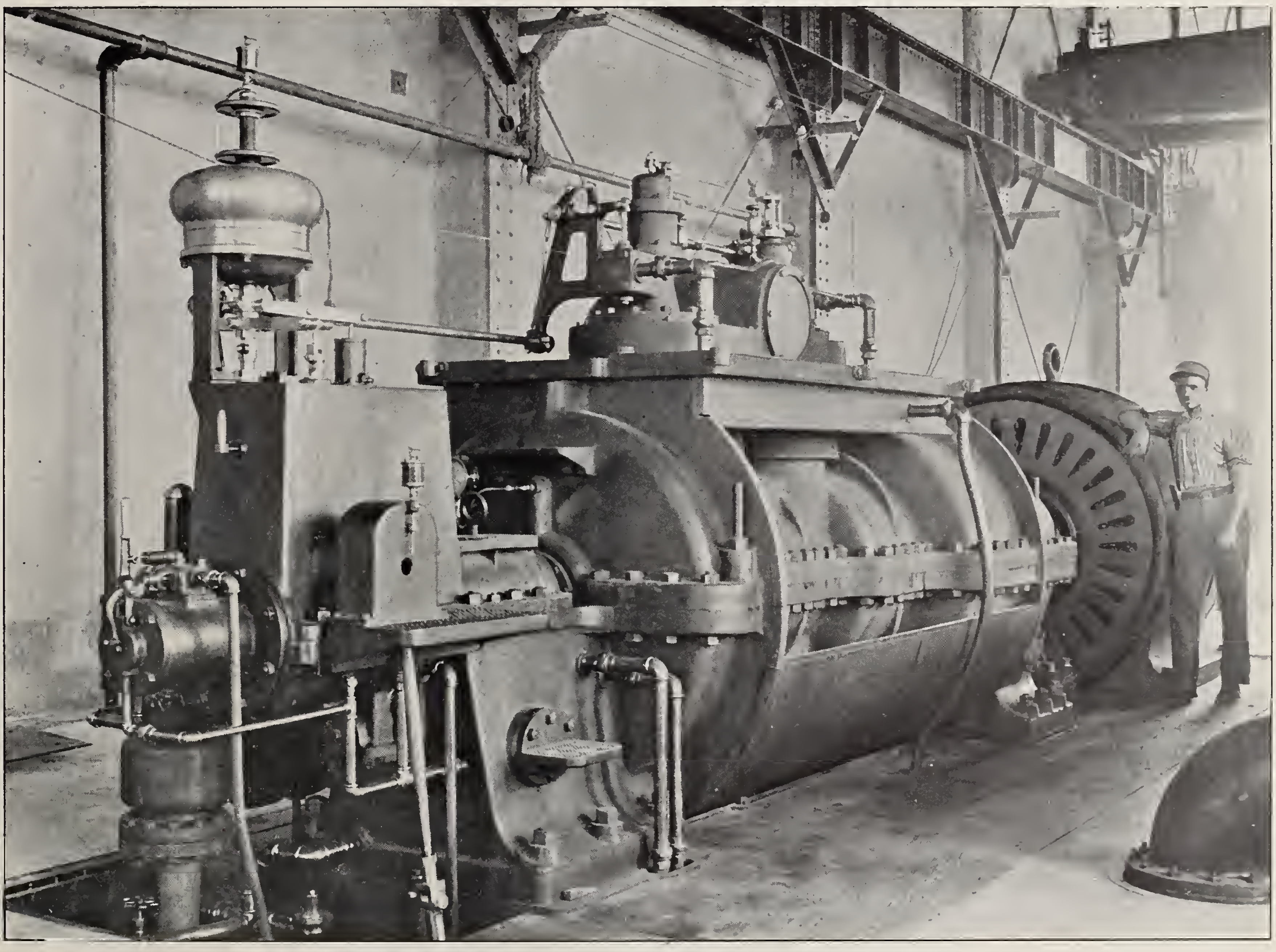
operation was so irregular that no dependence could be placed upon the service.

The existing lighting system, known as La Electricista, consisted of an interesting-looking building of typical Spanish architecture, filled with a lot of antiquated machinery in small units, and unable to supply the demand for current for lighting and power purposes.

In the construction of the new system several physical difficulties were encountered. In the first place, ordinary woods were unsuited for structural purposes on account of the ravages of the white ant which is found in great numbers throughout the island. A careful study of the woods used by the natives and of the reports of the United States Department of Agriculture, showed that but two or three varieties, which could be obtained in sufficient quantities, were immune from the attacks of the ant. Molave, a native wood, gave excellent satisfaction, as did jarrah, an Australian hardwood. Many experiments were also made with California red wood. This was considered favourably on account of the fact that it could be readily obtained in large quantities. It was found, however, that while the ants, as a rule, did not find it a tempting morsel, they would feed upon it when other woods, presumably more to their liking, were scarce.

The second difficulty was found in connection with the use of steel for rails and for structural purposes. The peculiar moist climate of the Philippines acts rapidly upon steel and it corrodes approximately twice as rapidly as under similar conditions in the United States. This fact made it necessary to paint the rails and joints with asphaltum, and all structural steel in the power plant and car shops construction was treated with a special carbon paint.

The power plant is located on an island in the Pasig River, nearly in the center of the territory to which it supplies current. The Pasig River furnishes a waterway to the ocean, making it possible to deliver coal, brought from Japan and Australia, directly to the power house by lighter. A crane unloads the coal and deposits it either in hoppers over the boiler room, or upon the ground for storage. Approximately, 30,000 tons of coal may be stored in the space provided. The main power station consists of an engine room and a boiler room, the former 47 x 170 feet and the latter 54 x 170 feet. Beneath the engine room is a basement containing the pumps, steam pipes, and accessories, the basement floor being on the same level as the boiler room floor. The frame of the power house is of steel, the walls are of poured concrete, while the roof and floor are of concrete slabs. One side of the boiler room is left open for a space of about 12 feet from the ground, to afford the ventilation necessary in that climate.



ONE OF THE WESTINGHOUSE-PARSONS STEAM TURBINE GENERATORS

The bearing value of the soil was very low, and it was necessary to drive piles 20 feet into a hard sand stratum, the top of the piles being

SOME OF THE OVERHEAD WORK

covered with a 2½-foot concrete mattress. All engine and machine foundations are also of concrete and piling.

In the boiler room there are eight Babcock & Wilcox boilers, rated at 400-H. P. each. They are arranged in two batteries of four each, on either side of a self-supporting steel stack, 175 feet high. Steam is generated at 200 pounds pressure and superheated to 600 degrees. The boilers at present are provided with flat grates, as it is proposed to experiment with the cheap native labour. Provision, however, has been made for a possible future installation of mechanical stokers.

Feed water is obtained from driven wells, and is raised by means of compressed air into a standpipe 14 feet in diameter and 60 feet high, located at one end of the boiler room. Condensed steam is delivered by the hot-well pumps to a steel hot well located in the boiler room immediately in front of the stack. Here it merges with the make-up water from the standpipe and is fed by gravity through feed-water heaters to the feed-pump suctions. Each boiler is also provided with a double-tube injector.

From the boilers superheated steam is distributed through an 8-inch main header, mounted on substantial structural brackets on the boiler room wall. From the header, connection is made to the steam turbines which are used by means of direct steam lines passing underneath the floor. Drains from the steam line are returned to the boiler through a Holly gravity system. Steam from the smaller turbines is condensed in 3000-foot Alberger surface condensers, while the larger turbines are connected to 6000 square foot condensers of the same type.

Along one side of the engine room are arranged three Westinghouse-Parsons 1000-H. P. steam turbines, direct-connected to three 750-KW. generators, and one 2000-H. P. turbine connected to a 1500-KW. generator. Provision has been made for putting in a second 2000-H. P. turbine, and in view of the rapidly increasing load, it is very probable this will be installed in the immediate future. This will give the station a nominal capacity of 7000 horse-power. The generators are three-phase, 370 volts, 60 cycles.

As this station is designed to serve both the street railway and the lighting and power circuits of Manila, it is necessary to transform a portion of the output into direct current. For the present the sub-station is located in the main power house. Approximately one-half of the entire output of the station is, therefore, transformed into direct current by means of three 500-KW. rotaries, 370-600 volts, and one 300-KW. rotary, 370-600 volts. One 125-KW. booster is direct-connected to a rotary. For the lighting and power distribution, four 250-KW. oil-cooled transformers, and four 500-KW. oil-cooled transformers raise the pressure from 370 to 3400 volts, the pressure on the transmission line. The switchboard contains 44 panels and extends along one side of the engine room,—a distance of 105 feet.

CHARACTERISTIC PASSENGERS. GOING TO THE MAYPAJO COCK PIT

A NATIVE TRACK-LAYING GANG

It is well designed for easy manipulation and repair.

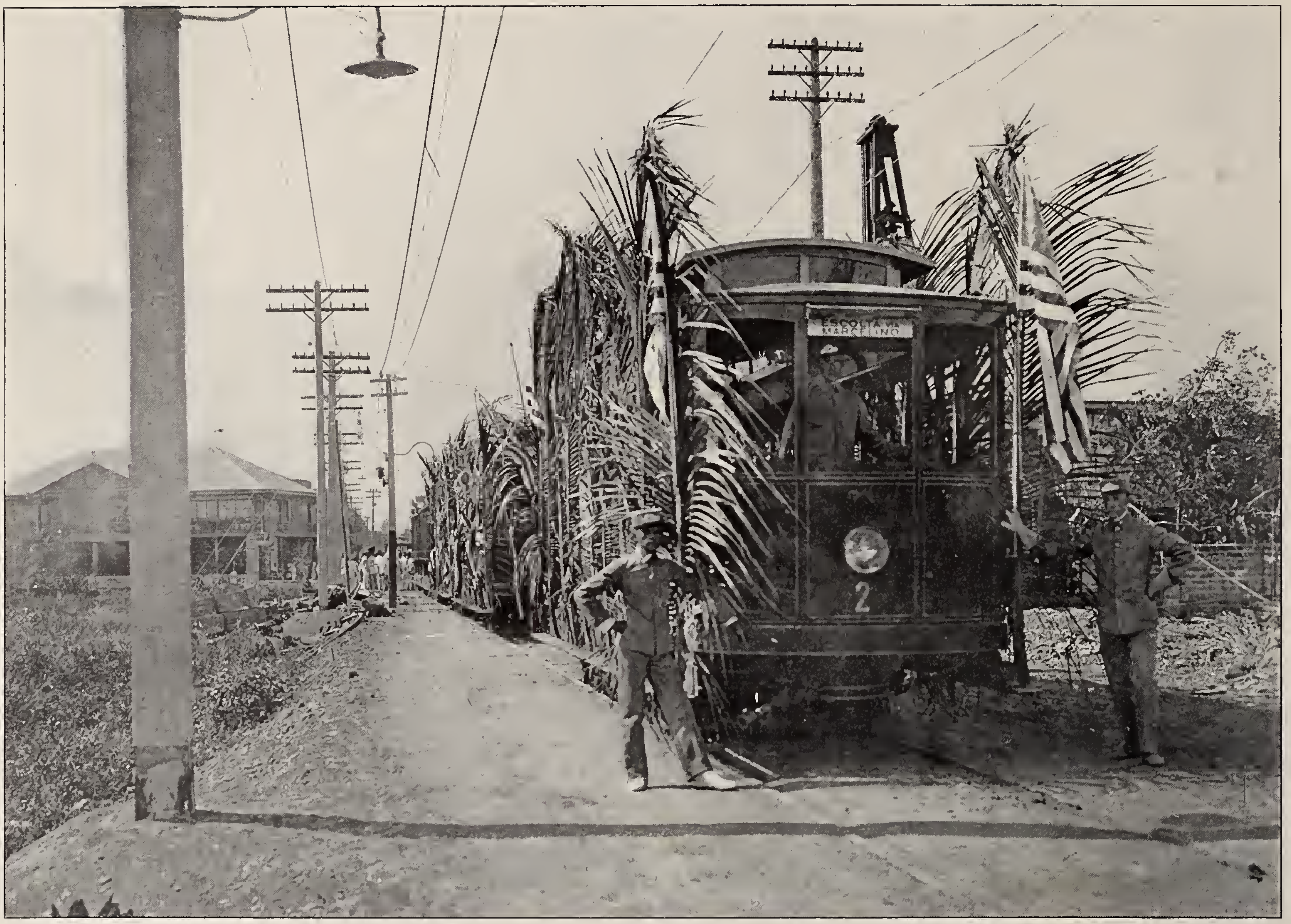
The 600-volt distribution is carried on 30-foot wooden and tubular steel poles, nearly all of the former being ipil, a native hardwood, dark and of dense structure. Both iron and wooden poles are set in concrete, the former being reinforced by a 4-foot section shrunk on and extending 2 feet below the ground. This reinforcement has been found exceedingly valuable, as the weakest point of the pole is at the ground level. It is estimated that the concrete and reinforcement practically double the life of a pole.

In the "intramuros," where the streets average but 20 feet wide, all wires are carried immediately over the streets on wooden brackets attached to iron tubing, this being supported at either end by 4-inch pipe, erected at the house line, with cross struts, raising them well above the balconies of the houses. This construction is well shown on page 170. In the newer sections of Manila, the streets are comparatively wide, and in these steel poles are used with handsome ornamental iron brackets.

The entire system is divided into eight separate districts, each independently fed from the power house. The trolley wires are equipped with section insulators, provided with bridging switches, thus making it possible to utilize the overhead copper to the greatest advantage. The feeder system contains the equivalent of 25 miles of No. 0000 cable. The light rails taken from the old horse car line have been utilized as return circuits by bonding together, connecting the load centers with the power house. Two trolley wires are used over all single track, these being placed about 6 inches apart, separating at turn-outs and switches. Where double track is used on adjacent parallel streets, one of the trolley wires is carried over each track. No. 000 B. & S. wire is used.

The track construction is of the very best. A 94-pound girder rail is laid in all of the paved streets, while in the outlying districts a 70-pound A. S. C. E. S. section T-rail has been put down. The rails are laid on ties, 24 inches from center to center, with special angle-bar joints, Harvey grip track bolts and lag screw spikes, instead of the standard railroad spike. These spikes are employed extensively in Europe, and necessitate boring the ties before the spikes can be screwed in by means of a socket wrench. They have, however, been proved a great success.

As in the case of track construc-



PARADE OF CARS ON THE OPENING DAY OF THE LINE. NOTE THE NATIVE MOTORMAN AND CONDUCTORS IN UNIFORM

TYPICAL PIPE STRUCTURE FOR CARRYING THE TROLLEY WIRES IN SOME OF THE NARROW STREETS. SEE PAGE 169

tion, the question of materials became an important one in the construction of the car bodies, largely because of the white ant. On this account the cars are built of steel and teak wood. The majority are of the modern cross-bench open type so extensively used in the United States during the summer months, while to provide for the rainy season, a number of convertible and semi-convertible cars have been provided. On account of the narrowness of the streets, the cars have been reduced to 7 feet in width, and five Filipinos find ample space on one seat.

The first order for cars was placed with the Belgium firm, La Metallurgique, while the Electric Railway & Tramway Carriage Works, of Preston, England, built fifteen semi-convertible truck cars. The orders were placed abroad on account of the inability of American car builders to bid on cars of teak construction. Later, the J. G. Brill Company, of Philadelphia, supplied fifteen full convertible cars. The single-truck cars are each equipped with two 40-H. P. Westinghouse motors, the

double-truck cars with two 50-H. P. motors. This equipment is larger than would be necessary under the same conditions of service and grade in the United States, and was necessitated by the high temperature in which they are required to operate. Peckham single trucks and Brill maximum traction trucks are used. On account of the distinction between first and second-class passengers, screened partitions are provided.

The Canadian system of fare collection by means of fare boxes is in vogue. Twelve centavos, or 6 cents, are the charge for a first-class ride within the city limits, extra fare being charged for every 2 miles on the interurban section of the line. The second-class fare is 10 centavos, or 5 cents.

In connection with this it is interesting to note that the adoption of a gold basis with the ratio of two to one, has resulted in an unquestionable stability in the monetary system.

The new issue of coins includes 1, 2 and 5 centavos, in copper, worth, respectively, $\frac{1}{2}$, 1, and $2\frac{1}{2}$ cents, and 10, 20, and 50 centavos and 1 peso, in silver, corresponding to 5, 10, 25 and 50 cents. The 10-centavo piece is of the same size coin as our dime, while the 1-peso piece contains approximately the same amount of silver as the American dollar. Tickets are also issued at reduced rates.

A fully equipped car shop of steel and concrete construction is located a short distance from the power house, and as it is the intention of the company to repair and ultimately to build all car bodies in these shops, they are equipped with a full complement of tools. Another department necessitated by the conditions is the printing office, in which all tickets, forms, time tables, advertising posters, etc., will be printed. This is probably an innovation in electric lines of this size, although some of the largest systems in the United States have their own printing offices.

Taken all in all, it is little wonder that Manila is proud of her city and interurban railway. The latest reports from the treasurer's office indicate that the railway is supplying the traditional long-felt want, and one that is destined to work many changes in the social fabric and growth of the city.

PAY DAY FOR THE MANILA RAILWAY CONSTRUCTION GANG

Metering Electricity

By JOHN W. LIEB, Jr.

From a Discussion Before the American Institute of Electrical Engineers

ONE of the most interesting questions in connection with supplying electricity is the proper metering of the product. There is not the proper public confidence in the systems of metering ordinarily in use, to which the results obtained would seem to entitle them; and there is also, unfortunately, no adequate legislative provision as to what really constitutes an accurate meter.

It is obvious that when a meter is tested under laboratory conditions, with ideal surroundings, it is possible to eliminate vibration, stray fields, variations in current strength, and other factors that affect the accuracy of the test. It is also possible to eliminate the personal equation and the errors of the test itself, and greater accuracy is to be expected and can be attained than when one undertakes to test a meter in a dark cellar, probably by candle light, located high on the side walls, or in other places difficult of access, and with a testing current that is influenced by a neighbouring elevator motor and subject to variations of current and pressure—in general, where the conditions for conducting the test are wholly unfavourable.

Hence, there is considerable variation as to the requirements that can be imposed or the results that can be expected in a meter test made on a customer's premises, as compared with a test in the laboratory. It is somewhat difficult, on the other hand, to persuade a customer that a test on a meter that has been removed from his premises and the influence of local conditions is a satisfactory one. He feels that the meter should be tested under the conditions and in the location in which it is to be used.

Unfortunately, as already mentioned, there is no legislative provi-

sion or municipal regulation, or even accepted custom, which clearly defines what shall be the conditions of test to obtain commercial accuracy, and this is the more remarkable when one considers that large amounts of money depend on the indications and registrations of such instruments. We hear from time to time about erratic meter performances, not only in regard to the accuracy of the electric meter, but also as to the indications of its elder brother, the gas meter. It is often difficult to reconcile the opinion a customer holds in perfect good faith, as to the amount of current he believes he has consumed, with the actual indications of his meter; and I know of no more difficult task than that of satisfying a customer who believes that in a certain month he has used only half as much current as in the preceding month, and yet receives a bill of substantially the same amount, as shown by the meter. On the one hand, one is face to face with a question of fact, as registered by the best instrument that is available, and on the other hand with a matter of belief, which may be the result of personal observation, or, what is more likely, a general impression as to what the conditions of use may have been.

We all know that the tendency of most recording apparatus in use is to run slow. As to the extent to which apparatus of this character runs slow under commercial conditions, of this it is difficult to speak; but the ordinary types of commutator meters must, of necessity, considerably under-record.

To begin with, it is difficult, owing the maximum demand which each installation is likely to make upon the street service, to obtain a total meter capacity that is much less than the total installation capacity connected with the street mains. It is not difficult to obtain a satisfactory ratio in the case of residences, but it becomes difficult in installations that have variable demands and in which sudden changes in current strength and unusual demands must be taken care of. For this reason it is considered good practice so to proportion the ratio of meter capacity to installation, that some meters may be burned out from time to time; and it is safe to infer that a supply system in which no meters are ever burned out, is "over-metered"; that rate at which meters burn out gives a rough indication as to whether an economical policy is being pursued in selecting the appropriate sizes of meters.

Assuming a ratio of meter capacity to connected installation capacity of 1 to 1, we find that under the conditions of heaviest load on the system, the meters, on the average, will then operate at only 30 to 50 per cent. of their capacity; and since the heaviest load on a large system lasts for little more than one hour a day, for only a few months in the year, and during the months of light load, and for considerable periods of the day and night the load carried is insignificant, the meters will practically work under conditions where the load is considerably under 10 per cent., and probably not over 5 per cent. of their capacity. Now, we know what the results are of operating meters on loads well under 10 per cent. of their average capacity.

To get an approximate idea of the conditions that may be expected on a large system, I will give a few facts as to commercial accuracy of meters in every-day service. The figures refer only to commutator meters. In a large meter system that is kept in good condition, the records show that of 1000 meters tested at random on the customers' premises, after they had been in operation for about 1 year, 75 per cent. were between plus 5 and minus 5 per cent. of absolute accuracy; and of the remainder approximately twice as many were slow as fast; the average accuracy of all the meters was 98.12 per cent.; and only 2.7 per cent. of the whole number were more than 10 per cent. fast. The tests were made under what may be considered full-load conditions, that is, at 50 to 100 per cent. of the meter capacity. Under light-load conditions of 10 to 25 per cent. of the meter capacity, 50 per cent. of the meters were between plus 5 and minus 5 per cent., and of those outside of this range, four times as many meters were slow as fast.

Those who have to do with apparatus of this kind should carefully consider the conditions under which results are obtained, and in case of doubt should thoroughly investigate these conditions before questioning the accuracy and reliability of the metering instruments.

The Export Shipping Company, of New York, advises the Department of Commerce and Labour that the company has decided to adopt a suggestion made by an officer of the department in an article appearing in the "Geographic Magazine" in 1901. It is proposed to equip a large steamer and furnish space thereon to American manufacturers to make a display of their products and send them around the world on a trip to consume about fifteen months.

A New Storage Battery

At a recent meeting of the Deutsche Bunsen Gesellschaft, Dr. Grafenberg, of Kalk, near Cologne, described a new non-lead accumulator. The positive electrode of this cell is formed of the black nickel hydrate obtained by chemical oxidation of the lower nickel hydrate formed at the anode in an electrolytic cell. The negative electrode is formed of iron powder obtained by reducing ordinary forge scales of iron oxide in hydrogen gas at 380 degrees C. The nickel oxide is then mixed with 40 per cent. graphite and the pulverized iron with 10 per cent. of graphite, this being covered with a coating of electro-deposited nickel before use.

The materials are then pressed into briquettes, and these are enclosed in small capsules of thin nickel steel, and again submitted to pressure. Ten of these charged capsules are joined together to form the positive and negative plates of the cell. The author exhibited a cell containing six pairs of plates, enclosed in a sheet steel box pressed out of one sheet, and therefore without joints. The total weight of this cell was 6.6 pounds, made up as follows:—Active materials of the cell, 31.6 ounces; metal capsules and supports for the same, 26.4 ounces; electrolyte, 22 ounces; steel box, etc., 25.52 ounces.

As electrolyte, a 20 per cent. potassium hydrate solution is employed, which must be free from acid radicals, organic substances, and carbonic acid.

Under the normal conditions of 4 hours' discharge, this cell yields 35 to 40 ampere-hours with a mean electromotive force of 1.23 volts. This represents from 16 to 18 watt-hours per kilogram, or 2.2 pounds of total weight. The volume of the cell is 2.9 litres, or 0.76 gallon per 100 watt-hours. The resistance of the cell increases on discharge; the mean for small cells is 0.0035 ohm.

The terminal pressure is less constant than with the lead accumulator cell, and the discharge can be continued until this has fallen 20 per cent. The standing electromotive force is 1.35 volts. The charging electromotive force rises quickly to 1.60 volts, and then slowly to 1.80 volts.

The United States Government is preparing to install a space-telegraph system throughout the Lower Yukon district of Alaska to replace the land lines that have proved a failure to a large extent, owing to forest fires, floods, cold weather and other obstacles.

Gas Producer Power Plants

By SAMUEL S. WYER

A Paper Presented at the Washington Meeting of the American Institute of Mining Engineers

THE installation of the gas producer power plant in America has been so unusual that all engineers have viewed it with interest; a large majority, however, regard it with a lack of confidence and many with positive distrust. Despite the fact that European engineers have usually been less inclined to take the initiative along experimental lines than are Americans, they have, nevertheless, developed the gas producer plant to a very high state of efficiency, to which they were forced by the necessity of economy in fuel consumption.

The gas producer power plant is so common in Europe that engineers as well as the general public regard it with the same degree of confidence that is now universally placed in steam plants. Gas engines, both small and large, are in general use there, and central stations aggregating several thousand horse-power are quite numerous.

The fact that gas producer power plants have received so little attention in America may be attributed to five conditions:—(1) ignorance and prejudice, (2) newness of work, (3) inadaptability of gas engine, (4) fuel economy not imperative, (5) smoke nuisance not given attention.

1. Ignorance and Prejudice.—The only literature pertaining to gas producer power plants is that found in the various technical journals and in the transactions of engineering and other technical societies. In many cases the papers are of a fragmentary character, and seldom are they complete or comprehensive. It may be that the lack of reliable data available to engineers is the cause of the ignorance and prejudice that exists concerning this important branch of engineering.

2. Newness of Work.—The manufacture of producer gas is an old process, and gas engines have been developed to a very high stage of mechanical efficiency, hence there is no valid reason why such installations should be regarded as experimental.

The Winchester Repeating Arms Company, at its plant in New Haven, Conn., has a Loomis-Pettibone gas producer plant, built primarily to furnish gas for fuel purposes (such as for annealing ovens, furnaces, etc.); a 100-H. P. Westinghouse gas engine was installed some time ago, and later three direct-connected units, each of 175 H. P., have been ordered. At the present time this example is one of the best instances in America of an industrial producer gas plant where gas is furnished both for fuel and for power.

The following list comprises some of the larger gas producer power plants now in operation in America:—

Moctezuma Copper Company, Nacozari, Sonora, Mexico.

Guggenheim Exploration Company, 700 H. P., Santa Barbara, Chihuahua, Mexico.

Detroit Copper Mining Company, 1000 H. P., Morenci, Ariz.

Rockland Electric Company, 1000 H. P., Hillburn, N. Y.

Potosina Electric Company, 600 H. P., San Luis Potosi, Mexico.

Velardeña Mining & Smelting Company, 2000 H. P., Velardeña, Durango, Mexico.

Sayles Bleacheries, 250 H. P., Saylersville, R. I.

It is obvious that much has already been accomplished in this important field of power generation.

3. Inadaptability of Gas Engines.—No gas producer power plant can be successful unless the gas engine is adapted to suit the particular gas available for its use. On the authority of Westinghouse, Church, Kerr & Co., an engine which will develop 100 H. P. with natural gas will give only about 80 H. P. with producer gas—a loss of 20 per cent. With a 200-H. P. engine this loss would be about 15 per cent., and with sizes above 300 H. P. it would be about 10 per cent. Hence, the obvious necessity of designing the engine to suit the particular fuel it is to use. Several failures have been made by neglecting this important point.

4. Fuel Economy Has Not Been Imperative.—In the list of plants given above, it will be noticed that most of them are in remote regions where the cost of fuel is high, hence the high economy of the gas producer plant was necessarily a feature that commended itself.

5. Smoke Nuisance.—The laxity of the laws regarding the smoke nuisance has not made it imperative for manufacturers to give attention to the prevention of smoke. As soon as regulations concerning the smoke nuisance are enforced the gas producer industry will receive a new impetus on account of the easy solution that the gas producer plant offers for this trouble.

The following data relative to the design, operation and maintenance of gas producer plants are given to show their advantages:—

1. Solution of Smoke Problem.—A good gas producer, from the very nature of its construction and operation, does not allow the smoke to escape into the atmosphere; hence the gas producer itself presents a practical solution for the elimination of the smoke nuisance. The non-requirement of a chimney means a large saving in the first cost and in the maintenance of a power plant, and is an additional advantage in plants where the æsthetic features of the design are of importance; for instance, in the case of a municipal power plant.

2. Labour.—The cost of labour required to operate a gas producer plant is about the same as that required in a steam plant of similar size. However, during the time that a gas producer power plant is idle it requires less attention than does a steam boiler.

In the case of a municipal pumping station, the labour required to operate the producer gas plant would be one-half that of a similar steam plant, the gas plant being operated as follows:—The gas producers to use coal for supplying the gas to operate a three-cylinder vertical gas engine direct connected to a triplex double-acting power pump. In this case the usual fire engine will be dispensed with, and, should a fire occur, the requisite pressure will be obtained by pumping directly into the system. For ordinary domestic supply the pump will deliver the water into a water tower, from which the mains receive the supply as

needed. In every case the maximum quantity of water required during a fire is much larger than the average domestic consumption; hence the pump must be designed for this maximum quantity. As a result, the working of the pump at its full capacity for 6 out of 24 hours would furnish enough water for the daily domestic consumption; the pump would usually be operated from 7 to 10 a. m. and from 3 to 6 p. m.

A gas holder of sufficient capacity to run the pump for 30 minutes is to be filled before the producers are closed down. Compressed air is to be used to start the engine, which may be put into motion simply by moving a lever. The engineer is to live adjacent to the plant, so that when an alarm is sent in to the hose company, and simultaneously to the engineer's home and to the plant, it would be possible for the engineer to have the pump at work direct into the system by the time the fire company could reach the fire and make hose connections.

Since the gas holder would supply the engine until the producers could be started, the above scheme of operation eliminates the necessity of a night fireman and the keeping up of at least 70 pounds of steam pressure in a steam plant. A similar arrangement could be equally well adapted for fire purposes in connection with large industrial plants.

With regard to the skill required, a producer gas power plant does not require any greater skilled labour than does a steam plant of similar size; however, in some cases it may require time for men trained to handle steam apparatus to become accustomed to gas engines and gas producers.

3. Cost of Installation.—Two well-known engineering concerns give the following data:—

The cost of gas power plants, including gas generating plant and gas engines, up to 500 H. P., is about 25 per cent. higher than the cost of a steam power plant of similar size. Large plants, from 1000 H. P. upward, cost about the same as a first-class steam plant of similar size.

4. Costs of Repairs.—The cost of repairs on a gas producer plant will not exceed that of a boiler plant.

5. Use of Cheap Fuels.—In order that a gas producer plant shall be commercially successful, it must be able to make, from a low-priced fuel, gas that is sufficiently clean for use in an engine. Bituminous slack is usually the lowest priced fuel to be had; however, anthracite culm, or even wood, may be cheaper in some localities. In all cases the percentage of sulphur must be low if the gas is to be used in a gas engine. Frequently the use of a mechanically washed coal will be economical.

6. Scrubbing the Gas.—The only reliable way to remove tar and other hydrocarbons from gas made from soft coal is to have the producer so arranged that the gas comes in close contact with an incandescent mass of carbon. No mechanical means has yet been found to be successful, although several forms of centrifugal apparatus have been tried. For the removal of fine dust particles, however, centrifugal fans have proved very satisfactory.

7. Fuel Economy during Hours of Idleness.—The stand-by loss of heat is very small, being limited to radiation only; a gas producer is tightly closed during the time it is not making gas and the entrance of air is thereby prevented. This feature is a marked advantage over a steam boiler under similar conditions.

8. Time Required to Start Producers.—Even after a producer has been idle for several hours it may be started and can be working at its full capacity within 15 minutes. A gas holder is generally used in connection with the producer, from which a supply of gas can be taken to start the gas engine instantly and keep it in operation until the gas producers are making gas.

9. Time Required to Stop a Gas Producer.—A gas producer may be stopped instantly by simply shutting off the supply of air and steam.

10. Composition of the Gas.—The gas from the gas producer is quite uniform in composition, and as it usually passes first to a holder before reaching the gas engine, it becomes thoroughly diffused, thus insuring a still greater uniformity.

11. Thermal Efficiency.—The thermal efficiency of gas producers is generally about 80 per cent., and in some cases it is even higher than this value.

12. Automatic Feeding.—It is much easier to use an automatic feeding device on a gas producer than on a steam boiler, because all producers are placed vertically and the fuel can be dropped into position by gravity. The use of an automatic feed always decreases labour and insures more uniformity in the composition of the gas produced.

13. Rate of Gasification.—The rate of gasification in a gas producer is relative to the character of the coal used. The best rate determined by experience is 12 pounds of coal per square foot of grate area per hour, although some makers have advised as high as 20 pounds of coal. Experience has also demonstrated that too rapid driving opens a wide door for the admission of adverse gasifying conditions.

14. Poking the Gas Producer.—The amount and frequency of poking a gas producer will depend on the nature of the fuel and the design of the producer. The mechanical agitation of the fuel bed (as in the Kitson and Fraser and Talbot producers) eliminates poking entirely. In using bituminous coals the difficulties of clinker formations is augmented by the production of coke. The judicious use of a steam blast and automatic feeding will generally reduce poking to a minimum and, in some cases, will eliminate it entirely. Hand poking is very laborious for the attendant, and usually it will be shirked whenever possible. Gas will usually escape around the poke holes while the producer is being poked, which will vitiate the air in the producer room and also affect the regularity of the composition of the gas.

15. Calorific Value of Producer Gas.—The calorific value of producer gas varies from 125 to 150 B. T. U. per cubic foot.

16. The generation of 1 brake horsepower per hour with from 1 to 1.25 pounds of coal or 3 pounds of wood is very common producer gas power plant practice at the present time, and the gas contains at least 80 per cent. of the heat energy resident in the fuel.

17. No Loss from Condensation. —A very important advantage of the producer gas installation is that the gas does not condense or lose power on its way to the gas engine. On the contrary, the cooler the gas the better it is for the engine. With steam the condensation is considerable.

18. Leakage of Gas.—It is easy to prevent leakage of gas from the piping, owing to the low pressure of the gas (about 2 inches of water); whereas, with steam, there is often much loss and inconvenience on this account.

19. Saving in Shafting.—By using isolated engines a large saving in shafting may be made in many cases. It is not possible to do this in steam plants and still maintain a good economy.

20. Floor Space.—The floor space required for gas holders, gas producers and auxiliary apparatus is about the same as that required in a steam plant; the holder, however, need not be placed adjacent to the producers, but at any other convenient place.

21. Control of Operation.—A gas

producer plant is under much better control than the average steam plant, because in the gas producers the air supply rate of gasification as well as the fuel supply can be regulated more easily.

22. Storing of Heat Energy.—One of the most potent advantages of the gas producer plant compared with the steam plant is the ability of the former to store the heat energy in a holder where it may be drawn upon for immediate use. In this way irregularities and fluctuations of load need not affect the regularity of the action of the gas producer. This condition means an economy of operation and convenience of use that are impossible with any steam plant.

23. Dual Use of Gas.—Another important advantage of the gas producer power plant is that, in many cases, the gas may be used both for power and for metallurgical purposes, the same pipes being used to supply engines and furnaces. The plant of the Winchester Repeating Arms Company, at New Haven, Conn., illustrates an installation of this character.

24. Economy of Water.—In many cases it is a serious matter to secure a sufficient supply of water for a steam plant and sometimes, even with an adequate supply, the quality of the water is such that it is entirely unfit for use in a steam boiler. One of the most annoying difficulties of many steam plants is the trouble caused by the corrosion and subsequent cleansing of the boilers, together with the maintenance of feed-water purifiers.

The gas producer power plant forms an almost ideal solution for the problem of water supply. With a producer in normal condition, the consumption of water will not exceed 2 pounds per brake horse-power-hour. The water used in cooling the gases in the scrubber may be cooled in a simple tower and used repeatedly.

25. Operating Isolated Machines. —There is no difficulty in piping gas for several thousand feet in order to reach an engine that drives an isolated machine; this often makes it possible to dispense with abnormal lengths of line shafting and the consequent friction loss or other unsatisfactory methods of power transmission. This condition is especially valuable in places where electrical power is not used.

26. Range of Sizes.—Standard gas producers now range from a few horse-power to more than 500 H. P. in size.

27. Danger from Explosion.—There is less danger of explosion in a gas producer plant than there is in connection with a steam plant; moreover, should an explosion occur, it would be much less violent and destructive than that of a steam boiler.

28. Location of Producer Plant.—If desired, the gas producer plant may be placed near the fuel supply, which in many cases would reduce the expense of transportation, the gas being piped to the gas engines of furnaces where it is to be used. This arrangement, which is impossible with a steam plant, means a decided saving in favour of the gas producer installation.

29. Future Field for Gas Producers.—The preceding paragraphs show the many strong advantages of the gas producer as a power generator; the large number now in successful operation shows that the experimental stage has been passed and that they have become a formidable competitor of the steam boiler. The time is not far distant when gas producer locomotives for railroad service, gas producer portable engines and gas producer power plants for marine service will be in common use.

The advantages of the gas producer for each of the above three classes are:—

I. Gas Producer Locomotives, being—

1. Smokeless.—a, Trains and stations may be kept cleaner; b, tunnels may be passed through with greater safety; c, comfort of passengers will be increased.

2. Cinderless.—a, Fuel loss will be decreased; b, comfort of passengers will be increased; c, large fire losses due to sparks will be eliminated entirely; d, insurance rates on property adjacent to railroads will be less.

3. More Economical.—a, In fuel, since the amount used would be less than one-half that used on steam locomotives; b, in water, since the amount used would be less than one-eighth that used on steam locomotives; c, in time, since the time required to take fuel and water will be less; d, in labour in firing on account of automatic feed and decreased amount of fuel used; e, in idleness, since stand-by losses are very low; f, in number of fuel and water stations required.

4. Safer.—Since the danger of boiler explosions is eliminated.

II. Gas Producer Portable Engines, being—

1. Smokeless.—a, Large fire losses due to sparks will be eliminated entirely; b, insurance rates on property adjacent to where an engine is used would be less.

2. More Economical.—In a, water; b, fuel; c, labour; d, time required to secure fuel and water.

3. Safer.—The danger of explosion being eliminated.

III. Gas Producer Power Plants for Marine Service, being—

1. Smokeless.—a, Ships may be kept cleaner; b, passengers will have more comfort; c, a battleship could conceal its location more easily.

2. More Economical.—In a, fuel; b, water; c, time required to fuel; d, bunker capacity; e, floor space; f, apparatus required, since all of the condensing machinery would be dispensed with.

An Electric Kitchen

THE Niagara Construction Company, Ltd., of Niagara Falls, South Ontario, Can., has placed with the Prometheus Electric Company, of New York City, an order for a complete electric kitchen, sufficiently large to prepare meals for fifty persons, and to be used on the occasion of the forthcoming opening of the new power house of the Ontario Power Company.

The equipment consists of an angle-iron table, 18 feet long, on which are mounted urns with a capacity of three-fifths of a gallon, with inner vessels for milk, coffee, and hot water; one oven calculated to take 25-pound roasts, or the equivalent; two large copper vessels for boiled dinners; three 12 by 18-inch broilers; one plate warmer, 45 by 16 by 30 inches, and one steam table 5 feet long by 2 feet wide, and designed for four compartments.

The total outfit is designed for consumption of 27 KW.

The New York Central Railroad recently placed contracts for a lot of new bridges for the West Shore line, and for the electrical equipment of the latter between Syracuse and Utica. More recently contracts aggregating a value of $200,000 were placed with the General Electric Company for four sub-stations and 15 electric car equipments. Work will be commenced on the conversion within a few days. The electrified line will be provided with automatic block signals and interlocking plants at important points.

A new discovery of coal is reported to have been made in Nova Scotia. Indications are that it covers an area of about 100 square miles. Its northern outcrop is about 9 miles in a straight line from where the Cape Breton Coal, Iron & Railway Company are operating at Broughton.

FIG. I.—THE SIEMENS-HALSKE MINIATURE ELECTRIC RAILWAY SHOWN AT THE EXPOSITION IN 1879

Electric Traction in Continental Europe

By FRANZ KOESTER

THE growth in the electrification of existing railways, and the construction of new lines have been due in great part to the continual and costly experiments, and the application of new systems in Continental Europe, where, strictly speaking, electric railways originated, the first commercial road for regular passenger service having been the Lichterfeld-Berlin line, $1\frac{1}{2}$ miles long, opened to the public on May 21, 1881. It may therefore be of interest to consider briefly the most prominent steps in the development since that time.

The progress in electric railroad engineering during the last twenty-five years is well illustrated in Figs. 1, 2, 3 and 8. The first electric locomotive ever built is illustrated in Fig. 1, hauling a small passenger train at the Berlin Exposition in 1879. This locomotive was of 10 H. P., operating on a voltage of 110, and was built after the design of Werner von Siemens, the great pioneer of the Siemens-Halske works in Berlin.

Fig. 3 illustrates an electric locomotive, designed by the same company about twenty-five years later, and operating on 10,000 volts, alternating current, with a normal capacity of 1000 H. P. Fig. 2 affords an interesting comparison with Fig. 1 in matter of speed, showing the Siemens-Halske car used at the Marienfeld-Zossen trials running at a speed of 125 miles an hour.

Fig. 8 shows a motor car used on the Lichterfeld-Berlin line. Three of these cars were in service, operating on a voltage of 160, with a capacity of 10 H. P., the current being supplied through the rails. The carrying capacity of these cars was sixteen persons, and the length was about 15 feet. Fig. 6 affords a comparison with a car about 60 feet long, used on the famous Valtellina three-phase road in Northern Italy.

The comforts offered by the electric car of to-day are apparent from Figs. 7 and 14. The latter shows the interior of a car on the Berlin underground and elevated lines. It will be noticed that the car is divided by a door, one compartment being for smokers. Where this is not provided, smoking is permitted on the front and rear platforms, or when a trailer is attached it may be used for this purpose.

Fig. 7 gives another example of cleanliness and luxurious equipment, illustrating the interior of a saloon car on the Valtellina road. In this car, as well as that shown in Fig. 14, light is ordinarily supplied by electricity, candles being provided for emergencies, as required by law. As the voltage supplied to the Valtellina cars is 3000 volts, an 8-KW., step-down transformer is installed, fur-

nishing current at 100 volts for lighting, heating and ventilating.

One will often find in Continental cities that the cars are small compared to those in American cities. They are, however, run on comparatively short headway, and during rush hours trailers are attached, as shown in Figs. 10, 11 and 12.

As in many cities the law prohibits standing in the cars, it may happen that a party of nine desires to enter a car in which only four seats are vacant, and on the platform are standing the number of passengers allowed by the number painted on the car. The party must then be divided, five entering the trailer or a following car.

Paying one's fare abroad is very troublesome compared to American practice. At the time of paying the fare, the smallest amount being usually from two to three cents, the destination must be stated. The passenger then receives a ticket on which the destination is marked. At intervals of about a mile and a half inspectors examine the tickets—a comparatively easy task for them, as no one is standing in the car, but rather annoying to the passengers. During a short trip of about 3½ miles, the writer was thus bothered no less than five times.

Quite often one will find the cars divided into two compartments for the accommodation of different classes of passengers. In many instances this is not so much for the company's benefit as for the convenience of the public, since it may happen that when one compartment is full, and the other is empty, certain people prefer to wait for the next car. In some cases a company is required to carry passengers in the first-class compartment at second-class rates, if the latter compartment is filled, a practice also common on steam roads in many countries.

Fig. 9 illustrates a car to which two trailers are attached. This car is divided into three compartments, including that for smokers, and is equipped with 60-H. P., 600-volt motors. This road operates between Duesseldorf and Krefeld, 15 miles, and was designed and installed by the Schuckert Company, of Nurnberg. As usual with this type of road, power is drawn from an overhead trolley.

There are several lines in Europe where the car is also provided with a plow underneath for underground contact, as shown in Fig. 16.

FIG. 2.—THE SIEMENS-HALSKE EXPERIMENTAL CAR RUNNING AT 125 MILES AN HOUR ON THE MARIENFELD-ZOSSEN LINE

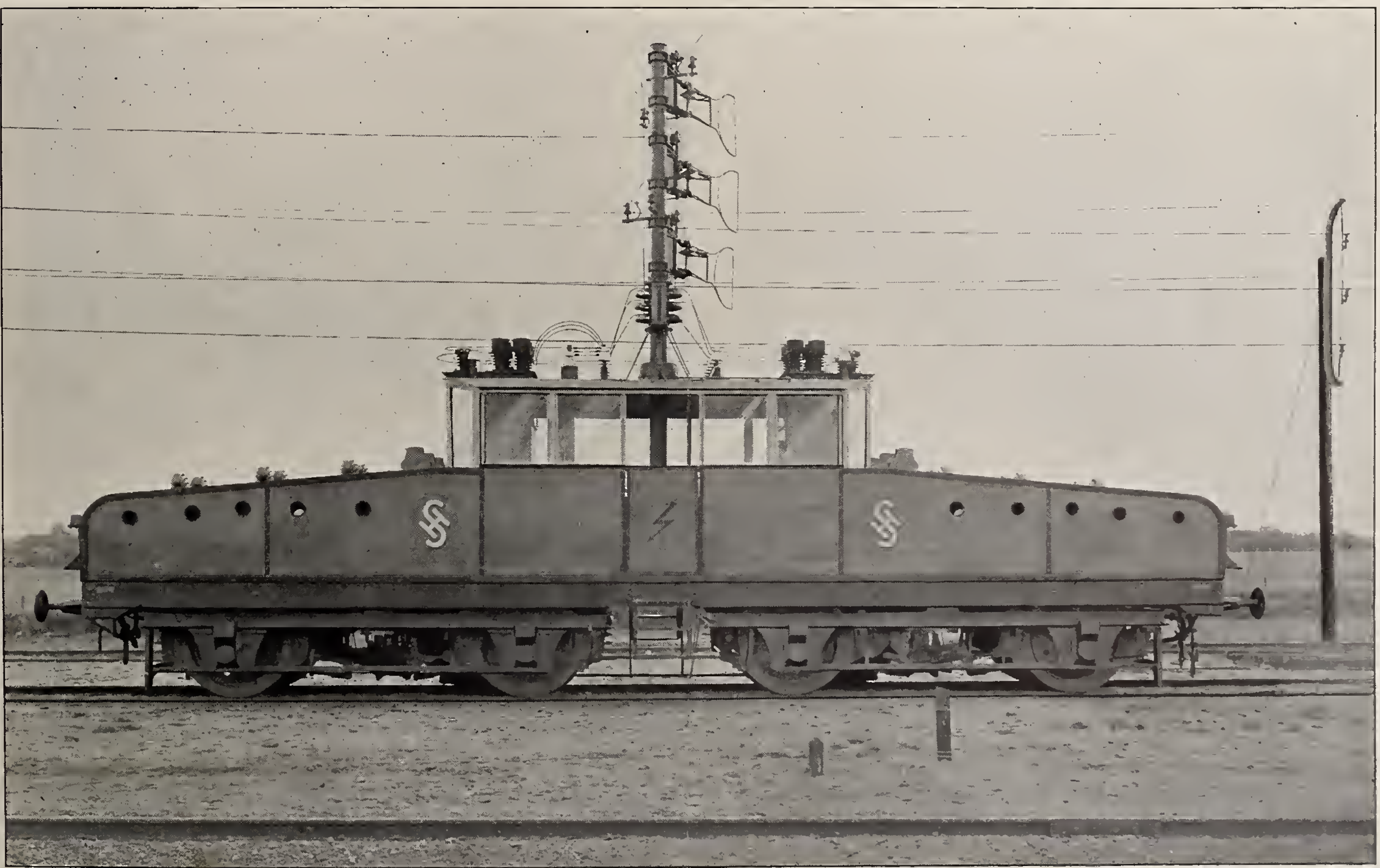


FIG. 3.—THE SIEMENS-HALSKE 1000-H. P. HIGH-SPEED ELECTRIC THREE-PHASE LOCOMOTIVE USED IN THE FAMOUS ZOSSEN TRIALS IN GERMANY

FIG. 4.—A TRAIN ON THE PRUSSIAN STATE ELECTRIC RAILWAY BETWEEN BERLIN AND ZEHLENDORF. THE MANNER OF PROTECTING THE THIRD RAIL IS CLEARLY SHOWN

FIG. 5.—OVERHEAD WIRES AT COLOGNE, GERMANY

FIG. 6.—AN EXPRESS TRAIN ON THE VALTELLINA ELECTRIC ROAD IN ITALY

FIG. 7.—THE INTERIOR OF A CAR ON THE VALTELLINA LINE

These cars, used on the municipal road in Vienna, are equipped on the Siemens-Halske system with a sliding bow for overhead contact, and also two plungers, one on each side, connected to the plow through a slot in one of the rails. Only one of the plungers is used at a time, being so arranged that the car conductor can in a few seconds, by means of a wheel and shaft, lift the plow, thus disconnecting from the underground trolley and connecting to the overhead trolley without stopping the car.

Although the capital cities of the Continent devote much attention to the beautifying of the streets, the overhead trolley system is certainly a great disfigurement, as will be seen from Fig. 5, affording a street view at Cologne. Even though the lines are very carefully laid out, the appearance is anything but beautiful. On account of the increased cost of an underground system, a combination with an overhead system is found in some cities like Berlin, Budapest and Vienna, where the underground trolley system is used only in the most prominent public squares and most important streets.

FIG. 8.—A CAR ON THE FIRST COMMERCIAL ELECTRIC RAILWAY, INSTALLED AT LICHTERFELD, GERMANY, IN 1881, BY MESSRS. SIEMENS & HALSKE, OF BERLIN

The cheapness of the overhead construction is especially noticeable with the employment of the sliding bow contact, allowing the poles to be placed 100 feet or more apart. Fig. 15 shows a line supported on double-arm poles of simple but handsome construction. On the continent of Europe one sometimes finds poles overloaded with decorative features to such an extent that all artistic effect is lost.

By the use of the sliding-bow contact it is practically impossible for the pole to jump from the trolley, and the sliding contact itself does not wear as rapidly as the rolling contact. It has other advantages, such as the lessening of noise, especially noticeable on parallel telephone lines, and the reduced liability of breaking the trolley. With extremely high speeds and high voltages, also, where the use of the ordinary rolling contact would have been impossible, a well-constructed sliding bow has proven most satisfactory.

The good features of this latter type of contact are apparently recognized in the United States, as the Westinghouse Electric & Manu-

FIG. 9.—A MOTOR CAR AND TRAILERS ON THE DUESSELDORF-KREFELD LINE. THE CARS ARE DIVIDED INTO COMPARTMENTS FOR DIFFERENT CLASSES OF PASSENGERS

FIG. 10.—ON THE ELECTRIC LINE AT MARIENBAD, AUSTRIA, A TRAILER ALSO IS ATTACHED TO THE MOTOR CAR DURING RUSH HOURS

FIG. 11.—A MOTOR CAR AND TRAILER AT HAMBURG

facturing Company has adopted it on the first single-phase railway system in America. This company has also adopted the sliding pantograph contact on their new 135-ton, high-pressure, single-phase, freight locomotive, the most powerful yet built. This is the first alternating-current locomotive used in America, and is designed for the high tension of 5000 volts, 25 cycles.

That the rolling contact has also its field of usefulness on the Continent of Europe may be seen in Figs. 17, 18, and 23, illustrating roads built by the Oerlikon Company, of Switzerland. This type of contact may be retained until special conditions are encountered, or where the speeds are extreme. The rolling contact is also common in freight service, as shown in Fig. 23, which illustrates a freight train on a railway in Wurttemberg, Germany. This line was also built by the Oerlikon Company in 1895.

Figs. 4 and 19 show trains for heavy passenger service, with third-rail contact. In Fig. 4 is shown a train on the Berlin-Zehlendorf road, consisting of ten standard Prussian passenger coaches as used on the steam roads, divided in sections, with side entrances. The third-rail protection is clearly shown. Fig. 19 shows a ten-car train on the Vienna railway, where the current is drawn from a third rail located between the two running rails. These roads were electrified in 1900 and 1901, respectively, by the Siemens-Schuckert Company, of Berlin.

Some of the conditions with which the builders of street railroads on the Continent of Europe have to contend, are shown in Fig. 25, which represents a car passing directly through a building in Aachen, barely leaving space for passengers to walk on the side. It will easily be understood that conditions of this character, not uncommon on the Continent, limit the size and design of the cars, and permit the use in many cases of only one track.

In relieving the congestion on the surface railways, practice has tended more toward the adoption of the elevated than the underground systems, the latter being considerably more expensive, so that the former still holds its own in spite of many objectionable features. However, to-day this additional cost is willingly incurred, at least for building under the main streets of large cities, while the elevated may run in less prominent streets, as in Paris and Berlin.

Two of the greatest objections to the elevated road from the public point of view, are the structure and the noise, the latter due largely to the steel construction. Much has been done in regard to these objections on the Continent of Europe. The adoption of solid concrete floors on which is placed the ballasted roadbed, was found most effective in reducing the noise. Experiments were tried in Berlin many years ago, using rubber and felt layers between ties and structure, and very hard wooden plates between the rails and ties, all of which have proved more or less unsatisfactory. Rails placed directly on the iron structure, or on ties, produce greater noise than when placed on wooden stringers. Paris has also accomplished much in this direction, as well as in the æsthetic appearance of the railway structure.

The Metropolitan Railway in Paris is mostly underground. Only about 5 miles will be elevated, this, although strongly objected to by the public, being adopted on account of the crossing of the Seine, several railroads, and a valley. It is, however, of artistic design, having heavy ornamental cast-iron columns, majestically bearing the long spans of the elevated structure, while in other places, to vary the monotony, massive stone pillars along the boulevards give a fine appearance. The roadbeds are of a solid construction, and are thoroughly drained, while the stations are of great architectural beauty, and as fire-proof as is possible with the present state of the art.

FIG. 12.—A VIENNA STREET VIEW. TRAILERS MUST BE USED DURING THE RUSH HOURS

As already stated, the larger part of the Metropolitan Railway in Paris is underground. Part is still under course of construction: fifteen miles being already in operation. Great difficulty has been experienced in

FIG. 13.—A STATION ON THE BERLIN ELEVATED RAILWAY. THE THIRD-RAIL CONSTRUCTION IS HERE CLEARLY SHOWN

building the tunnel on account of quick-sand. One of the most important problems in connection with this undertaking was the construction of the large stations at the Place de L'Opera, where three lines cross, one above the other, the upper one 20 feet below the surface, and the lowest one 52 feet below, with the other in between. The three stations are, on their respective lines, close to the crossing. The stations in the subway are handsome, and the open entrances to them are of fine design.

Another fine elevated road is that in Berlin, being also in connection with an underground system. The architectural beauty of this most remarkable elevated structure must be credited not only to the builders, the Siemens-Halske Company, but also to the public of the city of Berlin.

Fig. 20 gives an idea of the steel construction, and in Fig. 24 is shown how the problem was solved of crossing two existing ways, one above the other, in the most satisfactory manner, from an architectural standpoint. It will be noticed that the elevated road runs through a building, which it was first decided to remove, but which was finally altered as shown. The construction of this road is very solid, the space between the beams being filled with concrete, and drained similarly to that in Paris, thus preventing the dripping of oil, and, on rainy days, water to the street below. This system has also its objectionable feature as it shuts light out from the street. At the stations the tracks, as well as the platforms, are covered, as will be seen in Fig. 13, which also gives a good view of the roadbed. It will be noticed that the third rail is unprotected. The trains are made up of three cars—two motor cars with a trailer of a different colour between. The motor cars are third-class, and the trailers are second-class, with seats arranged along the sides, as in America. The third-class cars are for smoking. The doors open on the side, and no door is provided for passing from one car to another, seats being placed at the ends of the car.

The excavation and the building of the Berlin tunnel were accomplished under great difficulties, as the ground is made up of alluvial soil and quick-sand. To overcome the difficulties, perforated pipes were driven on each side of the roadbed several yards below the tunnel bed, and were connected to pumps. The water was then kept down below the tunnel so as not to interfere with the construction. The tunnels are made absolutely water-proof, as the water level is considerably above the middle. Entrances and a station are illustrated in Figs. 21 and 22.

Budapest, always a leader in public utilities, has done more comparatively than any other city in Europe in electric traction. Here, on July 30, 1879, the first electric street railroad in the world was operated. In 1896, a short underground railroad, in connection with about 20 miles of electric street railway, was turned over to the public. While the greater part of the latter was of the overhead trolley system, about 6 miles was of the underground feeder type, the first ever built. It was installed by the Siemens-Halske Company, of Berlin.

In the tunnel, the current is supplied from a 2-inch rail, suspended from the ceiling. In the cars, one long seat is at one side, and cross seats are on the other side, thus giving an aisle off the middle. There are eleven underground stations, the kiosks, or entrances, being of great beauty.

To-day in Budapest as well as Vienna, there is not a single car drawn by horse. A recent report was published telling of the aldermen and prominent engineers and municipal officials riding in the last cars drawn by horses, before which a band proceeded playing funeral marches.

The many advantages of the Lange suspension railroad system induced the city of Hamburg to build a system similar to that of the industrial cities of Elberfeld-Barmen, which has been in operation since the beginning of 1901. The proposed Hamburg railroad will be about 13 miles long and will cost about 50 per cent. less than the cheapest underground railroad. The first section of the Paris underground line cost $1,160,000 per mile, while the Lange suspension road cost only $600,000 per mile. Besides that of cheapness, this system also has the advantages of not interfering so much with street traffic, either during construction or afterwards, and it may be run over rivers, as is done in the case of the Elberfeld-Barmen road, shown in Fig. 27, crossing the River Wupper.

On account of the single track and the suspension car a much

FIG. 14.—INTERIOR OF ONE OF THE BERLIN ELEVATED AND UNDERGROUND CARS

FIG. 15.—A NEAT DESIGN FOR A DOUBLE-ARM POLE IN VIENNA

greater speed may be attained. Experiments have shown that on curves of about 100-foot radius, a speed of 35 miles an hour may be attained,—hardly possible with a surface or ordinary elevated road. On this road, curves of a radius as small as 26 feet are used, and grades as high as 4.5 per cent. As the cars are suspended on single rails, the entire width of the elevated structure is only the distance from center to center of the rails. This is about 50 per cent. narrower than that of the ordinary elevated, resulting in a cheapening of cost of construction and less obstruction of light and traffic. The trusses are built 98 feet apart.

As shown in Fig. 26, the cars are provided with two 2-wheeled trucks only, each having its own 36-H. P. motor, and on account of the low traction coefficient of this single-track system, a much lower current consumption is required than with an ordinary system. Much thought and attention have been given to the automatic block signal system by the Schuckert Company, the builders of the Elberfeld-Barmen road.

Power is supplied to the motors from the conductor directly below the rail. It is interesting to note that the power is furnished from the first successful complete steam turbine plant. The units are of the Brown-Boveri-Parsons type of 1000 KW. These are small, compared with the 5000-KW. turbines recently built by this same company for the electric traction system of Essen, Germany. Trains are made up of one motor car and trailer divided into first and second-class compartments, the motor car having a seating capacity of 30, and a standing capacity of 16, while the trailer has a seating capacity of 30, and a standing capacity of 20. The cars are of all-steel construction, probably the first steel cars ever built for electric railroading. However, they are not entirely fire-proof, as the seats and other details are of wood.

(To be Concluded.)

One of the features of the advent of electrically driven machinery has been the development of the electric blower. Originally the pulley-driven fan appeared to fulfill the requirements of the purchaser; soon, however, the steam fan with direct-connected engine displayed its utility, while to-day the fan driven by an attached motor has in turn shown its general superiority, and is rapidly supplanting the steam fan.

In single-floor electric light stations, according to C. L. Wiliams in a paper before the International Association of Municipal Electricians, not only the boiler and engine, but each dynamo and all shafting should be placed on a separate foundation laid in the ground, the dynamo base to be thoroughly insulated from the foundation by tar paper or ritrite sheeting, and water proofed. No part of the building should be used for the support of any piece of machinery. In good construction the building is only regarded as a cover for the protection of the plant, every part of which is erected as if the building foundation, or walls, did not exist.

FIG. 16.—A MOTOR CAR AND TRAILER ON THE MUNICIPAL LINE IN VIENNA. THE MOTOR CAR HAS A SLIDING BOW FOR OVERHEAD CONTACT AND A PLOW OR SHOE FOR UNDERGROUND CONTACT

The Ohio Electric Light Association

Some Papers Read at the Annual Meeting Last Month

Line Construction

By B. L. Chase, Superintendent of Line Construction of the Columbus, Ohio, Railway & Light Company

THE first consideration in building an electric light or power pole line is the question of location,—as a rule a difficult proposition in itself, for in most cities so many corporations maintain overhead lines as to make it a nice question, from an operative and commercial standpoint, which route could best serve the territory in view.

The probable opposition of property owners also must be considered and overcome, as this sometimes causes much delay and financial loss. Direct lines are, of course, the best, but are not always practicable, for in city construction many obstacles must be surmounted, such as the lines of competing companies, telegraph, telephone, and fire-alarm lines, trees, and instances where high-voltage lines might come too close to buildings and endanger life.

In laying out a line the poles should be located on lot lines, where possible, for you will find some property owners who always complain, and in most cases of this kind, if the pole is set on the lot line, you can with very little expense move it a few inches and satisfy them.

The future should also be taken into account,—poles should be located on the corners of intersecting streets, as such placing will simplify and cheapen the construction of lines on these cross streets, when such are necessary. The writer has encountered much trouble, in the rebuilding of old lines, through failure to observe this detail in the original installation.

In order to secure freedom from interruption, high-tension lines should be constructed above all telephone, telegraph and other wires for service of a similar character, for these conductors, being small and easily broken down by wind or sleet, will cause unending trouble to both companies, and be a constant menace to life and property.

An accident of this nature came under the observation of the writer some few months ago. A broken telephone wire which had fallen across a 4500-volt line at a point five or six miles from the power station, was lying across a fence. An Italian, in attempting to remove the wire from his path, was instantly killed, and his companion was also killed while trying to render assistance. In this case the telephone company settled with the families for twelve hundred and fifty dollars each.

High-voltage lines constructed underneath telephone, telegraph and other wires also endanger the lives of the employees of these companies, whose work necessitates their constant exposure to danger, by climbing between high-tension wires. Telephone linemen do not, as a rule, realize the importance of keeping entirely clear of the high-voltage cir-

FIG. 17.—ELECTRIC CARS AT ZURICH, SWITZERLAND

FIG. 18.—AT NISHNI-NOVGOROD, RUSSIA

FIG. 19.—ON THE VIENNA CITY RAILWAY. SEE PAGE 183

cuits, as their work is such that all wires may be handled without personal discomfort.

As an illustration of this condition, a few weeks ago a gang of linemen, employed by a long-distance telephone company, were stringing a pair of wires over a high-tension lead. They had pulled in but a few spans when they let the wires slack down across the high-tension line, burning it off and also the telephone line in several places, but fortunately causing no deaths.

Considering the enormous number of telephone and telegraph wires, and the constant work of maintaining them, it can be seen that it is imperative for high-tension lines to be placed above and entirely clear of all other wires. High-tension wires are several times larger, and being stronger are less liable to accident from natural causes; and the pole fixtures, being much heavier and of more substantial construction, are practically immune from accident.

A good road along a pole line is very desirable, and the route selected should be as free from obstruction as possible, and trees carefully trimmed, as even the small limbs will be the cause of much trouble.

FIG. 20.—ALONG THE BERLIN ELEVATED RAILWAY. SEE PAGE 185

Wood poles are the most desirable for high-voltage transmission, iron poles affording more chance for troublesome and dangerous grounds, and subjecting workmen to extreme danger from the same cause. Iron poles, however, have demonstrated their utility for low-voltage and railway work, and are more sightly in such cases where it becomes necessary to place them at close intervals.

For power transmission the poles should be both long and strong, in order to carry the circuits above all others and to stand the stress of heavy winds and sleet storms. All wooden poles should be shaved, painted, and gained before being erected, as the cost of labour in doing this work will be double after the pole is set on end.

For ordinary work, poles should be set 120 feet apart, or 44 to the mile; but local conditions will govern, especially in cities. The setting should be carefully done, and the poles kept as nearly in line as possible. Too much care cannot be taken in tamping, as a poorly tamped pole will be out of line after the first windstorm, and to straighten up, means unnecessary expense, and if left in that condition speaks but ill of the man who had charge of the work.

Hard yellow pine serves best for cross-arms, and for ordinary construction will give good results, but for heavy corners and junction poles

where the strain is great, oak arms should be used. Machine bolts, $\frac{5}{8}$ or $\frac{3}{4}$ inch in diameter, passing through both arm and pole, with a large washer under both head and nut, will be found the best for holding the arm securely in the gain. This method makes a cleaner and safer job than fastening the arm with lag screws, and permits repairs and changes to be made much easier. Lag screws are cheaper, however, and are sometimes used in ordinary construction, but should be avoided in heavy work.

For high-tension lines the cross-arms should all be double, and a block, securely bolted between the arms about 8 inches from the end, will materially add to their strength. The initial cost of this mode of construction will be somewhat higher, but will be cheaper in the long run. It practically prevents a wire from coming in contact with the arm through breakage of a pin or insulator, and the resultant effects (probable burning-off of the cross-arm and allowing the wire to fall to the street or upon other wires strung below).

Poles at angles should always be guyed at a point as near in line with the strain as possible. A very light pole properly guyed will withstand heavy strains, without distress, which would otherwise require the erection of a heavier pole.

In all cases great care should be exercised to keep guys clear of all other wires, and strain insulators should be cut in about 6 feet from the pole, which will assure a greater degree of safety to employees who work among the high-tension wires and the guy wires with which they might come in contact accidentally. Guying to trees is a very bad practice, for you do not know what minute they will blow down and cause trouble that would cost more than ten times the cost of a guy stub in the first place.

The most dangerous strains on overhead lines come from sleetstorms, ice sometimes covering the wire to a depth of an inch. Under these conditions the insulators and pins become the weakest points, and precaution should be taken in your construction to guard against such strains. A $\frac{3}{8}$-inch carriage bolt through the pin lengthwise will insure against a failure under almost any conditions, and will be found to be a cheap method of reinforcement. Other means for the prevention of accidents should be installed, such as iron guard wires at angles to keep wires from slipping off the arm, should a pin or insulator break.

Several head guys at corners or at the end of the line, will relieve the strain, and will, in case of accident to these poles, save several poles from being broken.

It is the belief of the writer that only in a case of emergency, work should be done on circuits of this nature while current is on the line, for it is extremely hazardous at best, and the method to be preferred is to complete all arrangements and cut the current off only long enough to make actual connections.

The different circuits should be so arranged that sections can be cut out by means of oil switches on poles, so that in no case would it be necessary to deprive a large number of customers of current. This system has proven very satisfactory, as it is comparatively seldom that the current is cut-off, and an explanation of the danger incurred by the linemen is generally satisfactory to any user of current who makes complaint. It is customary to do such work at a time when it will least interfere with the larger number of users of current,

FIG. 21.—ENTRANCES TO THE BERLIN UNDERGROUND RAILWAY

FIG. 22.—A STATION ON THE BERLIN UNDERGROUND RAILWAY. SEE PAGE 185

FIG. 23.—A FREIGHT TRAIN HAULED BY ELECTRIC LOCOMOTIVES ON A WURTTEMBERG ROAD. ONE OF THE FEW LINES ON WHICH THE SLIDING-BOW IS NOT USED. SEE PAGE 183

FIG. 24.—THE ELEVATED ROAD AT BERLIN. SEE PAGE 185

and only after notifying them, and considering their suggestions as to time.

The alternative, i. e., to carry current at all times, may result in serious and generally in fatal accidents, a number of which have occurred in the city where the writer is employed, through lack of observing the above suggestion. And the liability in such instances would more than offset the objection to an occasional deprivation of current.

A word might be said in regard to lightning arresters. These are generally placed at intervals of about a mile, and seem to afford protection to transformers, as it is but seldom that one is damaged. It is different with the arresters themselves, however, as several of these are lost in every storm. Many different types are in use, with but slight variation in results.

The line proposition resolves itself down to a careful study of all contingencies, the installation, of good material, thorough workmanship, rigid inspection and proper maintenance of every detail, as it is only by constant attention to these that the required service may be obtained.

Practical Suggestions on the Wiring of Residences and the Facilities Given to Consumers for Increased Use of Electricity

By J. Kermode

THE cost of wiring a house is not so important as the operating expense; therefore, the wires and their appliances should be properly installed. Lighting effects in each room must be studied, that the number of outlets and switches and their location may be decided upon. Before this can be determined in a new house, the man drawing the specifications or plans for the wiring must be capable of determining the relative position of the heavier furnishings in each room. When the outlets and switches are located for the entire house it may be found serviceable to write out a specification of lights by tabulating the centers, sides and baseboard outlets, also drop lights and switches, and by keeping a record of classification for several houses and comparing their relative cost for different classes of wiring, a fairly close estimate can be made by simply glancing at the tabulation.

A prospective customer usually makes his first inquiry at the office of the supply company and some one should be in a position to promptly inform him what would be most suitable for lighting his residence, with the approximate cost, which must necessarily be fairly correct. To be successful in this capacity the man must be thoroughly versed in the several methods of wiring that are employed, and the kind of appliances that would be best adapted for this purpose, and, in a general way, give information that will assist him. Undoubtedly the relations thereafter between the customer and the supply company will be more satisfactory than if he were to be misinformed by an outside party seeking additional profit for unnecessary or extra work.

With the inauguration of a policy of this kind better workmanship can be secured at a lower cost from competing contractors desiring the opportunity to submit an estimate or proposal on work of this character.

The work should be inspected from time to time as it progresses, and any deviation from the specifications brought to the attention of the owner, with a recommendation of the necessary procedure to rectify the mistake before the work has been completed.

The design of electric fixtures suitable for most living rooms usually brings the lamp close to the ceiling, and where this style of fixture is used two or more switches should be provided, and the fixture wired in sections to enable one to light part or all the lamps, as desired.

In addition to the center fixture, baseboard receptacles are necessary to make the system flexible. Lighting the room too brilliantly is a mistake too frequently made by users of electricity. Invariably this will be found true where only one switch has been provided on a fixture designed for several lights.

Some of the most beautiful effects and best lighting results have been obtained from oil lamps that have been converted into electric lamps.

Usually the light from a table lamp is sufficient for general illumination, while on special occasions a few or all the lamps may be necessary.

In smaller residences the reception room is generally drawing room, library and living room combined. A center chandelier in harmony with the style and character of this room will be suitable. As the lamps on this chandelier are more frequently used than any other lamp in the house, it is thought best that they be controlled from as many of the most convenient points as possible, and the lamps arranged on two circuits.

FIG. 25.—THE TROLLEY SYSTEM AT AACHEN, GERMANY. THE STREET HERE NARROWS DOWN TO A PASSAGE THROUGH A BUILDING. SEE PAGE 183

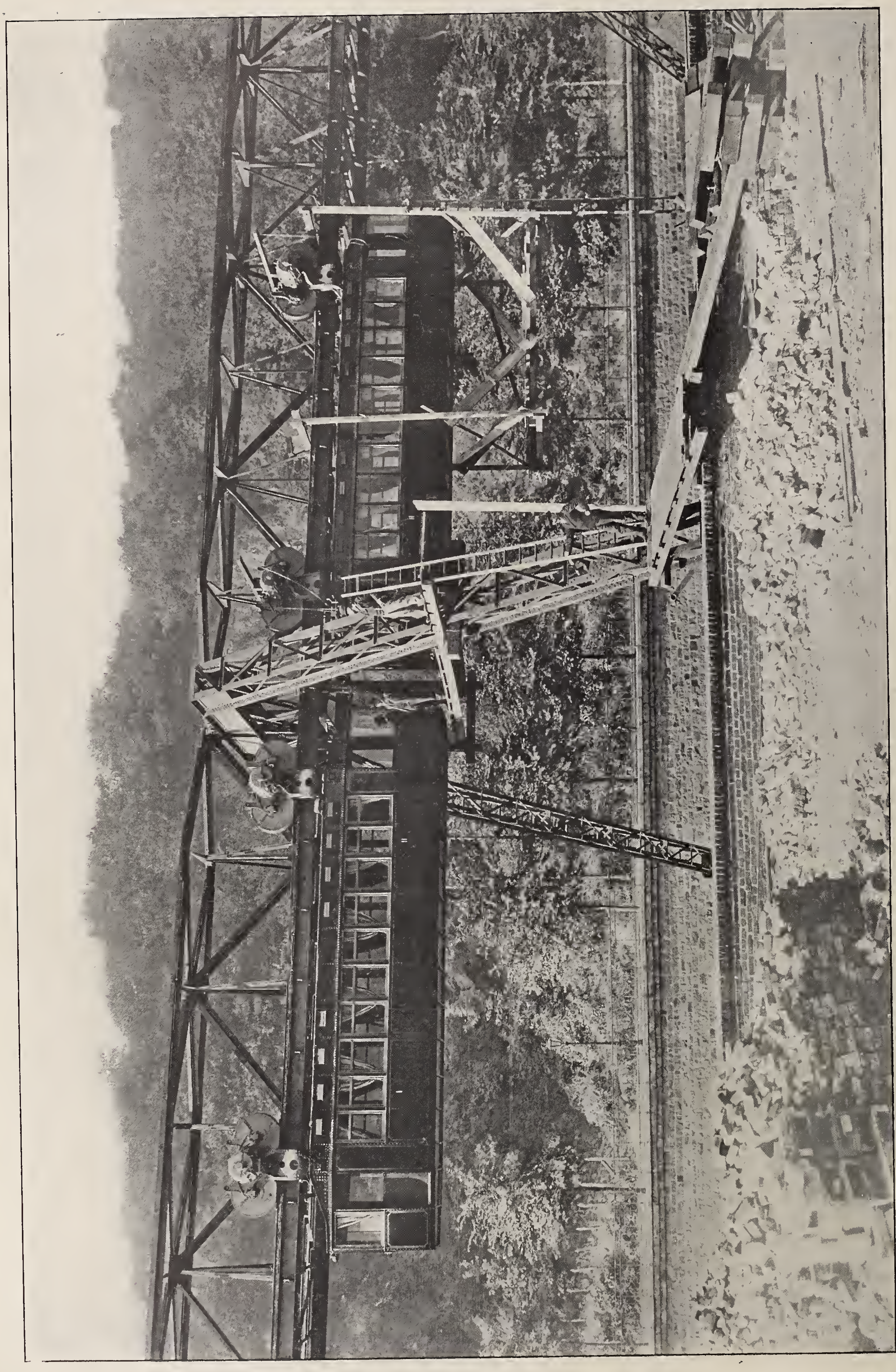


FIG. 26.—A TRAIN ON THE SUSPENSION RAILWAY BETWEEN ELBERFELD AND BARMEN. SEE PAGE 186

An odd bracket over a cosy corner, a small lamp, well shaded, directly over the music sheets, an ornamental fixture over the fireplace, or on the newel post, are suggestions suitable for a reception room. The best way of connecting odd brackets and portables is to install receptacles in the baseboard or floors near the point or place where the light will be most effective.

In the dining room a dome fixture hung low and over the center of the table gives very pleasing results. One 16-candle-power lamp under a dome of this kind gives sufficient light for all ordinary occasions, at other times a 32-candle-power frosted lamp, or a meridian lamp may be used.

After the dinner hour a soft low light can be readily maintained from a side bracket, or by a candelabrum placed on the china cabinet, which can readily be connected to a baseboard receptacle. One switch on the center outlet of a dining room is usually all that is required, although in larger residences it is sometimes advisable to place two switches, as lamps are sometimes extended from the canopies of fixtures.

The kitchen is a work room, and good light is needed, especially over the sink and range. A side bracket near the sink, and another near the range, is an excellent way to light it. This will be appreciated by those who have to work in their own shadows.

Drop cords have been the general practice in basement lighting. One of these may be controlled by a switch at the head of the stairs. This is good in small basements without partitions, but, as a suggestion, if all the drop lights in the basement were placed on a switch at the head of the stairs and a hylo lamp placed in each socket, then on entering the basement every room would have a low light, enough to see the way to any particular point where more light could readily be produced. To those who have experienced a second trip to the basement to turn out a light that had been forgotten, it does not require any argument other than their own experience to convince them that this arrangement has a value much in excess of its cost.

As electricity has many more comforts to offer in a home than its lighting features, sufficient outlets should be installed at various points in the house, where curling irons, hot water heaters, heating pads, sewing machine motors, refrigerator motors, and many other devices which are being extensively used can be attached. The economic value of hylo lamps have been well recognized, and their use should be extensively advocated in bedrooms, bathrooms, and halls, where an all-night light can be maintained at a low cost.

The size and arrangement of bedrooms in most modern houses does not permit the rearranging of furniture. For this reason dressers and beds should be located on the plans as near as possible to the place they will permanently occupy. When one center outlet is used in the bedroom

FIG. 27.—THE SUSPENSION RAILWAY AT ELBERFELD-BARMEN, GERMANY

a light placed in close proximity to the ceiling is better than two or three lamps suspended lower. This of course requires a switch to operate the lamp. In rooms where side brackets are installed, the chain-pull socket has many advantages over the ordinary key socket.

In sick rooms nothing equals electricity. The light may be arranged by or above the bed in such a manner that the patient may turn it off or on at will.

Here also the turn-down lamp will be found a great convenience, and so, too, will the electric stove, used to heat water, and other sick room necessaries in which heat is used. An electric fan may do more for a child than all the doctor's medicines.

Hot water bags were a boon to humanity when they were invented; the electric bag has superseded them. None of these devices are expensive and there is not the slightest danger in their use.

Bathrooms are very often poorly lighted. They should be properly lighted. A lamp on each side of the mirror is very helpful to the man who shaves. They are separately controlled and usually one only will be used.

Small electric stoves to heat water can readily be attached to the lamp socket and hot water obtained in a very few minutes. Side brackets are advised for bathrooms, lavatories and rear halls.

Clothes closets to be complete should be equipped with drop lights, and when lighted in this manner a chain-pull socket is better adapted than a key socket, as the former can readily be operated with one hand, while with a key socket both hands are commonly required.

An electric pressing iron, sewing machine motor, and good light are three factors highly important in the modern sewing room. The electric pressing iron has sounded the note of comfort for the laundress. It can be used in the kitchen or laundry, and the work done in three-quarters the time taken by other irons, and the room in which it is used all day will be just as cool as though no ironing was being done.

A porch light looks hospitable and makes a house look habitable; besides, the owner is a benefactor to the traveler in guiding him on his way, especially if the house number is printed on the globe. A wrought iron bracket or fixture suspended from the ceiling with a low candle-power lamp will make the porch an ideal spot in which to entertain on a summer evening.

Waste Products of a Central Station

By J. A. Bendure

A CENTRAL station is essentially a manufacturing plant. Like other commodities current is produced in quantity at the lowest possible cost, to be sold in smaller amounts at an increased price. It follows, of course, that the cheaper the current can be put on the wire the larger the margin between the producing cost and the selling price.

If the selling price remains the same and the byproducts are utilized, thus largely increasing the gross receipts of the plant, and with little if any increased operating cost, the increased revenue will help wonderfully in the declaring of additional dividends, etc. The practical manager should be a student of the various methods of increasing revenue and decreasing cost, and advocate such installations as will materially assist in accomplishing that end.

The utilization of exhaust steam due to the operation of electric lighting and power plants is an idea which first came into use in 1889, and I understand that the first paper read before any electric light association was in the year 1890, at which time very little information of more than theoretical nature could be given to the management of these properties. In the next few years very little was done other than to work out methods of construction and development of devices used, both in the station and in the underground work. As the growth of the utilization of exhaust steam for heating purposes progressed, the possibilities of large profits from this enterprise became more and more apparent to the central station managers, and during the past few years the growth of their business has been exceedingly rapid.

Naturally, many experiments have been made along the lines of construction, and methods of delivery of heat in the exhaust steam to the building to be heated, and to-day it is a well recognized fact that the system best adapted for the delivery of exhaust steam is the one which is the most flexible, the one in which the most accurate records of delivery cost and use of steam by the various customers are obtainable, and which is adapted to serve heat to any form of heating apparatus, found in the various buildings of any city, with the possible exception of stoves and furnaces and grates.

The delivery of steam itself seems to answer this condition, as the commodity without change can be delivered to the customer's radiators direct, requiring no alterations in his present piping, but simply the installation of a steam trap, and for the highest economy an economizing coil, to utilize the heat in the water of condensation accumulating in the various exposed pipes and radiators throughout the building heated; or, the steam can be delivered to a hot water heater designed to heat the water in a circulating system of a building which is piped for hot water radiation, thermostatic control being applied to the temperature of the water circulated.

The various vacuum systems now found in buildings can be utilized and, if the customer desires, an atmospheric system can be installed. The installation of the radiation can be so accomplished through the use of top and bottom-connected cast iron radiation, to supply which a ported or graduated type of supply valve can be used in such a manner that from one-fifth to four-fifths of any radiator can be heated at the will of the occupant of the room, thus insuring greatest economy possible in the quantity of steam condensed. In this latter mentioned system of house-piping no economizing coils or steam traps are required, and the maximum amount of pressure that the central station will have to deliver at the wall of the building to be heated is eight ounces. The construction of the underground systems should be of such design that the transmission losses can be accurately determined.

The district heating committee of the National Electric Light Association in its report last year at the Boston convention, stated that it had sent a series of questions to over 100 electric companies who were operating exhaust steam heating systems. They asked twenty-four questions, and received replies from something over fifty companies. Their twenty-fourth question was:—

"As a result of your experience do you consider from all points of view that your investment in the heating business was a good thing?"

Of the companies operating steam systems, all but three answered unqualifiedly, "Yes." One of the three did not reply to the question at all, and two had not paid enough attention to the heating business to know.

The companies that are operating their plants with strict knowledge of what they are doing; that have a sufficient amount of mains in and have a sufficient amount of business connected to utilize their maximum exhaust steam, and who sell their steam upon the meter basis at a price sufficient to pay a profit on all additional live steam which they make

during the light-load hours, report the best financial results.

During eight months of the year steam heat is a more staple article than either electricity or gas, so there need be no anxiety on the part of a station manager as to securing an output for his exhaust steam. The income per mile of steam mains is far in excess of either gas, electric light or water, and a very large majority of buildings pay from three to four times as much for heat as for light, water and power combined. Chiefly, success in this branch of the enterprise depends upon the following:—

A properly constructed plant.

Volume of business.

Proper method of charging for steam supplied.

Efficient management.

Charging by meter is fully as important, if not more so, in the sale of steam than in the sale of gas or electric current. Heat, being an invisible product, is more easily wasted than electric light or gas, and there is nothing to call the attention of the occupant of a room to the fact that heat is being extravagantly used and wasted unless a draft of cold air affects him, while the burning of an idle or a useless gas jet or electric light attracts his attention.

Steam radiation can condense several times more steam with a circulation of cold air about it than it would if surrounded by practically still air and at a warmer temperature. Further than this, when heat is charged for upon the square foot of radiation basis, the customer is likely to decrease the amount of radiation as far as possible, which means that the power plant must carry a much higher pressure in the steam mains to give the same satisfactory service, and at the same time at a lesser income than it should receive.

If charges are made by the cubic feet of space heated, the wasteful and extravagant use of heat will continue and at the same time a scale of prices would have to be made to apply to the various classes of buildings heated in which the kind of construction must be carefully considered, amount of glass and wall exposure in proportion to the cubical contents, whether double windows and whether strips are used or not, and the use to which the buildings are put.

A store containing hardware, glassware or drugs will use more steam to keep it at 72 degrees temperature than a store containing dry goods or clothing, and the different winters vary in intensity, which greatly affect the amount of steam required for heating. The factor of average outside temperature is not the only one to be considered as affecting the amount of steam used one season as against another, as the average wind velocity and average relative humidity both affect the quantity of steam required.

One company with whom I have corresponded and which has kept close records of matters connected with the heating business, has 125 residences, 66 business blocks, 6 churches, 4 schools, 1 hotel and a postoffice building connected to its lines. It reports as follows:—

The average amount of steam required per thousand cubic feet of space was:—

	1902-03 Pounds	1903-04 Pounds	1904-05 Pounds
In residences heated..	10,639	12,843	11,280
In business blocks.....	6,923	8,045	7,948
Schools	6,416	6,107	5,319

Schools were closed during the season of 1903-04 for about a month owing to fever epidemic.

	Pounds	Pounds	Pounds
Churches	4,051	3,663	3,305

Another company located in the Central West reports:—

	1902-03 Pounds	1903-04 Pounds	1904-05 Pounds
Residences	9,400	9,616	8,672
Business blocks	7,030	7,938	6,716
Hotels	5,410	9,539	6,039
Churches	2,480	2,443	.....
Public buildings	.....	6,114	5,538

Another plant 100 miles further West reported:

	1904-05 Pounds
Residences	6,255
Business blocks	4,383
Hotels	7,265
Schools	4,806
Public buildings	4,896

The factor of the greater use of steam of the first named western city over the latter per 1000 cubic feet of space heated in all of the different classes of customers was probably due to the fact that in the former case the steam was sold for $0.45 per thousand pounds net, and in the latter case $0.60 per thousand pounds, and under the higher rate the customers used a less amount of steam and were equally satisfactorily heated and at a less cost per 1000 cubic feet of space heated. You will also note that the quantity of steam used per 1000 cubic feet of space heated is greater in residence districts than in the business districts. This to a large extent makes up the difference in cubic feet of space heated to the lineal foot of mains installed.

A company just entering the field should be able without much difficulty to secure contracts for most of the buildings already piped, and if the company secures practically all of this business at the start it has therein an excellent nucleus to work on, and as the popularity of the service increases and as furnaces and individual heating apparatus break down, so the district heating business will grow.

If your engines are already operating as condensing units, the condensers can be detached during the heating months, as the advantages from the sale of steam far excel any benefits that may be derived from condensing while there is a demand for heat, and during the summer months the plant can operate condensing. At times when the full amount of steam is not required for heating, the plant can operate part condensing and part non-condensing, and in this way the plant will be most profitably operated.

In the construction of new central stations, or the addition of further engines, simple-cylinder engines, or compound engines designed with reference to the combination of lighting and heating, will be found the most economical.

The method of construction, including method of insulation, devices for taking care of expansion and contraction, provision for dry steam being taken from the top of the mains, and means accomplished for relieving the mains of any accumulation of water of condensation and the measuring of this condensation to determine the proportion of steam condensed in the street mains to the amount discharged into the mains, is one of the first and most important features to be considered by a company about to go into central station heating. Upon these factors depend the life of the plant, satisfactory service, cheapness of delivery, and the effects upon the operation of the power plant.

As a further reason for going into the district steam heating business, it is a well recognized fact that the ability to supply steam has often enabled a company to secure contracts for light and power which it would not otherwise have obtained.

This then, in turn, increases the load and the profits from the electric end, and also increases the amount of exhaust steam that can be sold for heating. While it is true that the demand for heat comes about the same time of the year as the demand for light, yet it is also true that it may not come at the same time of the day that the plant is producing its maximum amount of exhaust steam; in other words, the lighting peak and the heating peak may not be coincident; in fact, there is no reason why they should be.

That the service is of special value and is popular wherever introduced is evidenced by its rapid growth and the many requests for extensions of mains and service connections with which every manager is favoured without an effort on his part of advertising or soliciting. In many cases the

absence of furnace smoke or dust makes the service worth twice its cost to the customer whose stock of goods is of a delicate character. Insurance premiums are slightly lower in many cities, both on buildings and on stock, when the heating is supplied from outside sources rather than from furnace or local boilers.

It is essential that the rates be carefully fixed at the beginning of operation and that the cost of generating and distributing heat, plus proper investment, depreciation and dividend charges, be the basis of such rates.

While it may be possible to compare with daily and monthly load curves of a central station, a hypothetical curve representing the amount of heat required by a building of given dimensions and thus estimate how much live steam can be added, the result is at the best only an approximation. The only safe and reasonable rate is that based on the cost of supplying heat direct from the coal pile, or, in other words, on a live steam basis, and any exhaust steam available with the rates thus fixed can of course be used to a very decided advantage.

It is probable that many of the district heating plants primarily owe their existence to the fact that there was available a quantity of exhaust steam which they proposed to utilize for heating buildings, thereby deriving some revenue from the heat otherwise wasted. To the fact that any revenue received from this source is looked upon as net gain, and that managers fail to properly estimate the real value of the service to the customer, is due most of the reports of the venture as being unsuccessful.

As to the necessity of making the heating business a department by itself, with separate system of accounting, that would depend largely upon the size and importance of the enterprise. If the same degree of care is exercised in the management of the heating branch of the enterprise and its inception, development and conduct, as is shown in the other established and successful departments, there would be no reason to anticipate a failure.

A badly constructed plant and slipshod methods of management are certain to lead to disappointment. The manager who takes on steam heating with the idea that it is a simple matter of supply and demand and does not require an equal degree of business ability and intelligence as in the sale of electricity, is deceiving himself. As it is said "A little learning is a dangerous thing," so a little steam heating for a central station of large capacity is not to be tolerated unless the inside piping at the station is so accomplished that the exhaust from only a sufficient amount of engine capacity is being delivered under back pressure to the heating system as is required in the heating. While the effect of back pressure in the increased fuel consumption per KW. hour is but slight, if this back-pressure is permitted to apply against the entire capacity of a large station, and the revenue from the sale of exhaust steam is not much more than sufficient to make up for this increased KW. cost, the investment would not prove financially attractive. The steam demand in heating should be nearly equal to or more than the amount of exhaust steam produced at peak electrical load, and the rates for steam should be made upon the live steam basis, and under these conditions steam heating will prove wonderfully satisfactory to the electric company.

Many of the companies are now advocating and adopting a sliding scale of meter rates, based upon the quantity of steam used. Connections from street mains to the buildings to be heated should invariably be installed by the operating company, and an accurate record kept of the location, size of mains, etc. Records of cubical contents, glass and wall exposure, square feet of the various kinds of radiation, sizes of meters and traps in every building should be kept.

Resuscitation from Electric Shock

By E. E. Noble

It was my good fortune last year to witness a series of experiments, the result of which should be of very material benefit to men engaged in electric work, and which should be of interest to members of this association. The experiments were conducted by Dr. Geo. W. Crile, a prominent surgeon of Cleveland, who has interested himself very deeply in this subject for some time past, and Dr. J. J. R. McLeod, of Western Reserve University, of Cleveland. These experiments were conducted with a view to further strengthening the theory of the probable cause of death from electric shock and to determine, if possible, the practicability of resuscitating persons injured in this manner. There has been, until a comparatively recent date, some diversity of opinion even among surgeons as to the cause of death from electric shock. It would seem, however, from the experiments referred to, and from other experiments, that death from electric shock occurs from the effect of the electric current upon the heart, the circulatory system and the respiratory system.

There seems to be a marked difference in the susceptibility of different persons to electric shock, and the physical condition of the person receiving the shock has apparently a great deal to do with its fatal effect. For instance, a case is recalled of a lineman who received a shock through both hands at a pressure of about 1000 volts. This was so severe as to permanently injure both hands, necessitating amputation of several fingers. This shock was not fatal, as the man was apparently in excellent physical condition at the time he received it.

As an illustration of the other extreme, cases are recalled of men who have received what are considered very light shocks at pressures varying from normal lighting pressure up to 500 volts, and which have proved fatal.

Drs. Crile and McLeod conclude that death from the passage of a heavy current through the body is due to either temporary stoppage of the heart, or "inhibition," as it is termed by medical men, or to immediate action on the heart, causing what is called fibrillary contraction of the ventricles, or in other words, contraction of the muscular fibres of the heart, whose function it is to force the blood to the general circulating system and the lungs. There is also a fall of the arterial blood pressure. The blood pressure is the tension exerted by the blood upon the walls of the vessels under the influence of the heart's action, and may be likened to water pressure in a pipe line. Dr. Crile has made very extensive researches into the question of blood pressure in surgery, and has found that blood pressure may be raised by the use of a saline solution containing a certain portion of adrenalin, which is a drug obtained from what is known as the suprarenal gland, generally of the sheep.

In the course of the experiments previously referred to, several points were brought out which are interesting when considered in connection with practical work on high-tension lines. It was shown that an important factor in a fatal electric shock is the action of the current upon the heart itself, and that unless a relatively large part of the current passing through the body traverses the heart, the shock will not necessarily prove fatal.

It was further shown by the results of the experiments that it is the amount of the current passing through the body rather than the voltage, to which death is due. It was also demonstrated that by the prompt ap-

plication of artificial respiration, natural respiration could in some cases be re-established. Especial examination of the blood showed that electric currents up to 2300 volts caused no chemical or other changes in the blood itself, and animals whose blood was subjected to this test, and which were allowed to live, showed no later effects. Neither does the current cause any change in the tissue of the brain, spinal cord, or other nerve structures, as the animals subjected to this voltage, and allowed to live, showed no depreciation in function. For example, current at a pressure of 2300 volts was passed through the brain of a dog, laterally and vertically, over a period of one minute. The dog was then resuscitated from the immediate inhibition or temporary suspension of animation and allowed to live. No after effects were noticed.

The conclusions which may be drawn from these experiments are interesting. It will be noted that there is no destruction of tissue as has been generally supposed, except where burns occur at the points of contact. From the fact that to cause death it is necessary for a certain amount of current to pass through the heart it will be seen that the position of the points of contact constitutes a very important factor in a fatal electric shock. For instance, in receiving a shock the current may pass through the body from the left arm to the left foot, in which case a large proportion of the current would go through the heart, and the shock would be very apt to prove fatal, depending largely upon the resistance of the contact. On the other hand, a shock in which the current passes from the hand to the head or from the knee to the foot, is not apt to prove fatal for the reason that the current does not pass through the heart.

Owing to the fact that it is the amount of current rather than the voltage that causes death, it will be seen that the resistance of the points of contact will also play a very important part in the fatal effect of the shock. For instance, a man may receive a shock from the tips of the fingers of one hand and through the body to the ground, or through his coat sleeve or some portion of his clothing if it is at all damp, allowing only a small amount of current to pass through the body.

A shock of this kind will not often prove fatal, even if the heart does lie in the path of the current, if the patient is properly cared for after it has occurred. On the other hand, a man may firmly grasp a live wire while standing upon the ground, or he may lose his balance while working upon a pole and receive a shock, perhaps in itself only a slighft one, and may become unconscious and fall against the wires, which will, owing to the fact that he is unable to extricate himself, burn into the flesh, allowing a large amount of current to pass through the body. A shock of this character will in many cases prove fatal, depending, of course, on the position of the points of contact and the relative amount of current which passes through the heart.

The result of these experiments cannot help but be of benefit to men who are obliged to handle wires carrying high voltages. In order that full benefit may be derived from them, it would seem a good idea to map out a systematic plan of action to be followed in all cases of electrical injury. The workmen should be educated and trained in "first aid to those injured through contact with live wires." Many of the men employed in electrical lines are already familiar with the artificial respiration method of resuscitation from electric shock. This is not carrying the education far enough. Every man in this class of work should be plainly told just what he is expected to do in case of accident. Each man should be familiar with the general plan to be followed in these cases, and should be familiar with the locations of the different hospitals, and which, if any, are best equipped to take care of such cases. The men should be trained in detail as to what method to pursue in taking care of an injured person until the arrival of an ambulance or medical aid.

The following method of resuscitation is suggested by Dr. Crile:—"Place the patient at once upon his back with the head turned on one side; place one hand upon each side of the chest over the heart, then exert rhythmic or regular pressure at the rate of approximately 40 to 60 times per minute, so as to press air out from the lungs and cause the heart to empty itself; with each pressure upon the movable ribs air is forced out of the lungs and blood is forced out of the heart. With the recoil of the chest walls, air is taken into the lungs and blood into the heart. In this manner both artificial respiration and artificial circulation may be obtained, sometimes leading to immediate restoration of the normal functions of the heart and the respiration. This treatment should be begun at the earliest possible moment after the accident, and should be continued not less than 30 minutes. If it is a case of inhibition, that is to say, if the heart has been temporarily stopped by nerve influence, and the amount of current which has passed through the heart has not been sufficient to cause fibrillary contractions, the chances for recovery in most cases should be very good."

While this is being done, an ambulance should be summoned and the proper officials of the company notified, but this should not interfere in the least with the work on the patient. On the arrival of the ambulance, one man should be detailed to go with it and continue treatment up to the minute the patient is given into the hands of the hospital authorities.

One thing supremely important must be borne in mind, and that is promptness in applying restorative measures. As an illustration of the value of promptness in these cases, a case is recalled of a man who received a comparatively light shock, resulting in unconsciousness. After a period of about 20 minutes had elapsed after the shock, the patient opened his eyes for a moment and moved slightly, and closed his eyes again, after which it was impossible to revive him. There is good reason to believe that if restorative measures had been promptly applied in this case, death would not have resulted. It has been previously stated that death is due in these cases to either inhibition of the heart due to nerve influence, in which case resuscitation is possible, or to fibrillary contraction in which case resuscitation is not possible.

As it can be determined only by direct examination of the heart whether or not fibrillary contraction has taken place, and as it will be readily seen that this is impossible in casualty cases and can be done only by a surgeon, it must be strongly emphasized that there can be absolutely no distinction in the treatment of these cases, and that every case must be treated as though it were merely a temporary suspension of animation.

In these cases another point of extreme importance should be borne in mind. That is, do not cease work upon a patient unconscious from electric shock until every known means for his resuscitation have been made use of. Surgeons who have made this a study tell us that men have been revived after several hours' labour, and in view of this fact it is little short of criminal not to use every means to bring the patient back to consciousness, or perhaps properly speaking, back to life.

There is one other point in connection with the experiments previously mentioned that may ultimately prove

of deep interest to the men engaged in electrical work. The fact was brought out as stated, that death does not necessarily follow an electric shock unless a certain amount of current passes through the heart. From this it will be readily seen that if some method can be devised for diverting the greater portion of the current around the heart, the number of deaths from electric shock will be greatly lessened, perhaps almost eliminated.

It is possible that this may be accomplished by means of a light metallic gauze jacket to be worn next the skin, or by a system of metallic bracelets worn around the upper arms and connected by means of flexible conductors to a belt of some similar material worn around the waist or some part of the body below the heart.

From observations made in the course of the experiments, it is estimated that in the neighborhood of 85 per cent. of the total amount of current passing through the body can be shunted around the heart by means of a device of this nature. It would probably not be an easy matter to bring such a piece of apparatus into general use among electrical workers, and especially linemen. The chances are that they would be more or less skeptical as to its efficiency. At the same time it is probably worth a trial as an experiment, and Dr. Crile and others are at present giving this matter a great deal of attention. The safety of the men who have to handle wires carrying high voltages should, in the interests of humanity, receive careful consideration, and if by following some such plan as that outlined in this paper, the number of casualties can be reduced, or if a life can be saved that might otherwise have been lost, we may feel that we have at least tried to do our duty.

Methods of Selling Current in Cities of Twenty Thousand Inhabitants

By H. C. Ayers

THE question of rates is one of the most troublesome that the central station has to deal with, and although it has been frequently discussed, few valuable data upon the subject are available.

The new central station starting operation has almost nothing to base rates upon, and when an investigation is made to find out what other similar stations are charging, it is confronted with the astonishing fact that the prices range from $2\frac{1}{2}$ cents to 25 cents per kilowatt-hour. In flat rates, it finds a variation almost as great. This is due to many causes. Some stations charge almost all of their expenses against their lighting peak and consider day power largely in the light of a by-product, selling it at a very low price; other stations are engaged in the business of furnishing heat from exhaust steam, and in order to have a large quantity of exhaust steam for sale, they make very low rates for power. However, the main cause for this great discrepancy lies in the fact that the stations are entirely ignorant of their cost of production and have adopted their rates without careful figuring.

The official of a new company making an investigation to find a proper rate to adopt, can find no rational reason for the large discrepancy that he discovers and concludes that the cost of producing electricity is as little known as what electricity itself is. He therefore adopts the rate which is deemed advisable and starts operation, taking a gambler's chance on making a profit. If there is gas competition, he probably has an engineer figure what rate he must charge to make a certain amount of electrical illumination cost the same as with gas, trusting to its superior advantage for getting his customers. Two general methods of charging for current are now in use among the smaller stations of this country, one being a flat rate of so much per light per month, and the other a straight meter rate of so much per kilowatt-hour. Both of these systems are open to serious objections, and it is the purpose of this paper to describe a combination system using a fixed charge which is similar to the flat rate in combination with the meter charge.

The objections to the flat rate are pretty well known by most central station managers. The principal one is, of course, that your customers will waste current. It seems to be against human nature for a man to be careful if it costs nothing to be careless. The objections to a straight meter basis are, that it does not accurately distribute among your customers their proportionate share of the costs of supplying them, and will always cause some customers to be operated at a loss to the company and others to pay in excess by an amount which makes this deficiency up, or in other words, the one customer is helping pay the other customer's light bill, and this system discriminates against the long-hour user, who is by all odds the more desirable customer and the one the station wants.

The question of rates is by no means a simple one after several years of operation. The ratio between the maximum or peak load and the station's maximum capacity is constantly varying, the peak creeping up toward the capacity until it becomes necessary to install new machinery, when the capacity is again placed above the peak. These changes very materially affect the fixed cost.

I have assumed for the sake of illustration, a station of 300-KW. capacity with a peak load of 225 KW. and a total production of 500,000 kilowatt-hours per year. One year's costs of operating this station are assumed as follows, and are divided into fixed costs and varying or running costs as follows:—

	Fixed	Varying or Running
Fuel and water	......	$4,000
Oil, waste, packing and chem.	......	500
Officers' salaries	2,500	......
Plant labour	......	2,500
Freight, drayage and express.	......	100
Traveling and livery	200	......
Office sundries	100	100
Plant and line repairs	......	1,000
Taxes	800	......
Insurance	200	......
Depreciation	5,000	......
Interest	6,000	......
Totals	$14,800	$8,200
Grand total	23,000	......

Dividing the grand total by 500,000 gives an average cost of $0.046 for a kilowatt-hour at the switchboard, and this result has very little bearing on selling rates, as will presently be seen. The fixed costs are those that do not vary with the amount of current produced, but with the size of the plant or its capacity to produce a maximum amount, while the varying costs are those that vary with the production.

Dividing the total fixed costs by the maximum load of 225 KW. gives $65.78 per year; dividing this amount by 12 gives a result of $5.48, which is the fixed cost per kilowatt per month, and this amount should be received from each kilowatt of load which comes on the peak to cover the fixed costs, the varying costs being covered by a meter rate as follows:—

Assuming a loss in transmission of 50 per cent., we will have appearing upon the customers' meters 250,000 kilowatt-hours, and dividing this into the total running cost gives 3.28 cents per kilowatt-hour.

It will now be apparent that each kilowatt of the station peak should pay $5.48 per month plus 3.28 cents for each kilowatt-hour shown by meter, plus a charge for lamp renewals if they are furnished, plus a profit, and any system of rates which brings an income of less than this amount in any customer's case, is incorrect; any system which charges

in excess of this amount, also is incorrect.

We will assume for illustration that the old rates of this station were 10 cents per kilowatt-hour on a meter basis, or 50 cents per month for a 16-candle-power lamp on a flat rate, and that they now adopt a combination rate of 30 cents per month for each 16-candle-power lamp as a fixed charge, and in addition, all current shown by meter to be 5 cents per kilowatt-hour.

We will take a case of two consumers and see how the different rates correspond.

Consumer A uses 16.5 kilowatt-hours per month by using one 16-candle-power lamp 10 hours daily for 30 days.

Consumer B uses 16.5 kilowatt-hours per month by using ten 16-candle-power lamps one hour daily for 30 days.

NEW RATE

Consumer A....	F. C. $ .30	Meter 83c	Total $1.13
Consumer B....	F. C. 3.00	Meter 83c	Total 3.83

OLD FLAT RATE

Consumer A	.50
Consumer B	5.00

OLD METER RATE

Consumer A	1.65
Consumer B	1.65

The result would be, consumer A would take his light on a flat rate, and consumer B his on meter, and the station would lose on both, or if the station had only one rate, either the above flat rate or the above meter rate, they would have the losing customer in either case, and the probabilities are the other would use some other illuminant.

It is interesting to note in this case, that the flat rate brings the largest income and it is generally true that customers will willingly pay more on a flat rate than on a meter, the difference being that they will waste more than they pay for.

After finding these costs, a rate may be adopted consisting of a fixed charge and a charge for current as shown by meter, which will have the following advantages:—It will accurately represent your costs plus a profit in the case of each individual customer; it will be a rate upon which you can make yearly contracts; it will be a rate which will be attractive to the long-hour customer; it is also free from objectionable meter or discount complications; and last, but not least, your income and your customers' bill will not vary as greatly as on a straight meter basis. To illustrate the last advantage noted, I have taken at random twenty of my own residence customers and twenty business rooms, averaging the total consumption during the year, the lowest consumption for one month, the highest consumption for one month, and, in the case of the business rooms, the maximum load coming upon the peak.

We will first consider the residences. The total in this case was 188 kilowatt-hours per year, the lowest month being 7 kilowatt-hours, the highest month 28 kilowatt-hours. It is interesting at this point to note that the highest consumption for one month was exactly four times that of the lowest month. Most people do not realize that the difference is so much and are inclined to complain when the high-month bill is rendered. While it has in our experience never lost us any customers, it has resulted in some dissatisfaction and has necessitated a large amount of explanation on our part.

In figuring this up we have at 15 cents per kilowatt-hour,—

Total for one year	$28.20
Lowest monthly bill	1.05
Highest monthly bill	4.20

Assuming that the customer has an average of six lamps on the peak, the bills on the combination rate would be for the year as follows:—

Fixed charge	$21.60
Meter charge at 5c. per kilowatt-hour	9.40
Making a total of	$31.00

LOW MONTH

Fixed charge	$1.80
Meter charge at 5c. per kilowatt-hour	.35
Total	$2.15

HIGH MONTH

Fixed charge	$1.80
Meter charge at 5c. per kilowatt-hour	1.40
Total	$3.20

For the business rooms, the total yearly consumption was 1040 kilowatt-hours; low month, 54 kilowatt-hours; high month, 145 kilowatt-hours; maximum load on peak, 950 watts; total yearly consumption at 10 cents per kilowatt-hour........ $104.00

Low month, at 10c. per kilowatt-hour	5.40
High month, at 10c. per kilowatt-hour	14.50

Same on the new rate,—

Total for the year, fixed charge	$62.40
Meter charge, at 5c. per kilowatt-hour	52.00
Total	$114.40

LOW MONTH

Fixed charge	$5.20
Meter charge, at 5c. per kilowatt-hour	2.70
Total	$7.90

HIGH MONTH

Fixed charge	$5.20
Meter charge, at 5c. per kilowatt-hour	7.25
Total	$12.45

From these figures the advantage of keeping the bills more uniform will become apparent, and while in the special cases cited the total results are practically the same, it will readily be seen that the long-hour customer, who would use twice as much as the figures given with the same capacity on the peak, would have the additional current charged him at the low rate. This will illustrate the advantage of this system to the long-hour customer, and, not only that, it encourages the customers to be liberal in their use of light, they knowing that after the fixed charge is paid, the meter rate being low will allow them to use liberally without a proportionate increase in the total bill.

In the application of this form of charging, there must be a classification of customers.

All customers who come regularly on the peak should pay the full fixed charge for the capacity connected to the station lines.

All 6 o'clock closing customers coming on the peak during the winter season should pay the full fixed charge.

Lodges and such clubs or meetings as are held but once a week should pay one-sixth of the full fixed charge, plus a certain small percentage to cover irregularities; this is for the reason that the same station capacity that was used by one on Monday night, would be used for another on Tuesday night, and so on.

Churches use on Sunday night the capacity used by stores during the week, but should pay some fixed charge to cover midweek meetings and extra meetings of various kinds.

Residences should pay the fixed charge on perhaps one-third of the capacity connected, this being fully up to their requirements at the time of the peak. At times there will be entertainments when a residence will use nearly all of its lights, but these times never occur in many residences on the same night, and are, therefore, taken care of by a very small station capacity, and as one-third is probably a high estimate of the portion of their total equipment turned on at the time of the peak, it would amply cover this extra requirement. I have also considered this one-third as being high enough above the average residence requirement to cover the extra cost of serving residences due to their scattered location and the necessity with alternating current of furnishing large transformer capacity.

The adoption of this rate might in some cases cause customers to wire only that part of their residences which would be used on the peak, and in this case they should be charged the full fixed charge instead of one-third. It would be advisable to designate which rooms should be on the fixed charge and make a general rule to govern.

Most stations have some customers who use electric light during the summer season on account of its freedom from heat and during the winter season use gas. They also have other customers who for various reasons would not enter into a yearly contract. Customers of this

kind could be charged a high rate for one hour daily or thirty hours per month for their maximum requirements, and a lower rate for all current in excess of this amount, the thirty hours at the high rate to be the minimum bill to be rendered in any case, whether the current was consumed or not. Rates similar to this are in use in a number of the larger cities at the present time, and this rate amply provides for each customer paying his proportionate share of the fixed costs of operation.

There is, however, one advantage in making a fixed charge rate as described in this paper, and that is, that it affords an opportunity of making contracts for one year or more, and it is advantageous to make the rate for intermittent customers high enough so that there will be a decided advantage to them in contracting for a longer period. In many cases an electric light company is losing very desirable business and a good revenue on account of the customer not wishing to go to the expense of his first wiring equipment.

I think it advisable for all of the smaller companies who do construction work to have a form of contract running three or five years, under which the equipment remains their property, and get such customers as are standing off on this account to use their product on this contract; they can well afford, in consideration of a contract of this kind, to stand the cost of the labour and the depreciation on the equipment. Customers who never have their load on the peak could be furnished current on the meter rate and pay no fixed charge, but such a customer would be very rare, and it would probably be better to have them pay a small portion of the fixed charge to cover irregularities.

Each class of customers will have to be treated separately and considered as a detail of the business by the manager, who should give the matter careful attention and see that the correct fixed charge is made, bearing in mind that the total fixed charge of all customers should represent the fixed cost as figured from expenditures.

I have found the following form of contract well adapted to the "fixed charge" system of selling current:—

CONTRACT FOR ELECTRIC CURRENT

This contract, entered into this ......day of ......, 190.., between the........Electric Light & Power Company as party of the first part, and ....as party of the second part, witnesseth:

That the party of the first part shall furnish electric current for ......purposes in the building occupied by party of the second part, situate at........, Ohio, upon the following terms and conditions, to to wit:—

	Current per kw.-hour	Fixed charge per month
......motors at		
......arc lamps at		
......incandescent lamps at		
......		
......		
......		

Said party of the second part agrees to pay to the said party of the first part a total fixed monthly charge of......as per the above schedule, and in addition agrees to pay for all current consumed as set out in the above schedule.

A discount is to be allowed of ......cents per 1000 watt-hours upon all bills paid by said party of the second part at the office of the said party of the first part on or before the 10th of the month following the service rendered.

The said party of the first part shall deliver the electric service to the building occupied by said party of the second part.

The said party of the first part shall furnish and install a watt-hour meter.

The said party of the first part shall furnish and install the lamps as per the above schedule and shall replace burned out incandescent lamps and keep other lamps in good repair and proper operating condition during the life of this contract.

The service line to the building, the meter and the lamps are to remain the property of the said party of the first part and to be removed by them at the expiration of this contract. The said party of the second part shall furnish all wiring equipment which shall be necessary in the carrying out of this contract, and the same shall be done in a proper manner and according to the rules of the National Board of Fire Underwriters and subject to the inspection and approval of the said party of the first part.

Said party of the second part agrees to give said party of the first part due notice of any interruption of service and allow a reasonable time for the proper repair of the same, and further agrees that the agents or employees of the said party of the first part shall have access to his premises at all reasonable hours for the purpose of inspections and test.

The party of the first part shall have the right to remove the meter installed for the purpose of testing the same or making repairs and may install another one in its stead. In case of interruption of service, party of the first part shall not be liable for any damages caused thereby. In case it should become impossible for the said party of the first part to furnish electric current to the said party of the second part, due to causes such as fire, strikes or any causes beyond the control of the said party of the first part, it is agreed that the said party of the first part shall not be liable for any damages whatsoever, that said failure to furnish current shall not be an abrogation of this contract and a deduction shall be made only for the term of interrupted service.

This contract shall be and remain in force for a term of......years from the......day of......, 190.., and at its expiration the same shall be regarded and understood as renewed from year to year, but either party may terminate same at the expiration of any year by notice in writing given 30 days prior to said expiration.

The....Electric Light & Power Co.,
By........
....

Dated ....

Platinum in Russia

ACCORDING to the report of the British consul at St. Petersburg, 95 per cent. of the world's platinum comes from the Ural district. The total production in 1902 was nearly 6 tons, that for 1903 about 5.7 tons, and for the first ten months of 1904 it was 4.7 tons. There are two or three refineries in Russia, but most of the product is exported in the raw state. Little enterprise is shown in prospecting, but the recent discovery of two nuggets, respectively 20½ and 9½ Russian pounds in weight, has had a stimulating effect. During 1904, there was a considerable shortage in production in the case of the larger firms who had entered into contract on the basis of the previously ruling lower prices.

For the electrical operation of gold dredging boats on Alaskan rivers, an entirely new plan has been evolved. The power house, which will be located at Dawson City, will be equipped with a 400-KW. generator, operated by a 600-H. P. steam turbine. Lines for transmitting this power will be strung from the station to wherever the dredges may be operating on the Yukon and its tributaries. On the boats will be installed induction motors of an aggregate of about 500 H. P., in sizes ranging from 7 to 100 H. P. each.

Combined Public Water Supply and Electric Power Generation

By ALTON D. ADAMS

THE commonwealth of Massachusetts is to develop from 3000 to 10,000 electric horsepower at the Wachusett dam in the town of Clinton. This dam is 850 feet long between its terminal structures, 207 feet high above bedrock, and will hold back 63,000,000,000 gallons of water. Closing the deep, narrow valley of the Nashua River, the dam raises its waters 129 feet above their natural bed, and creates behind it a reservoir 9 miles long.

October, 1900, saw the contract closed for this dam, and the work is now almost completed. At the full-reservoir level, 20 feet below the top of the dam, the latter is 25 feet thick, and 175 feet below the reservoir surface the thickness is 176.3 feet. The dam is composed entirely of rubble masonry faced with ashlar, all of granite laid in natural cement mortar, mixed with two-thirds sand, except that Portland cement is used in the deepest part of the toe.

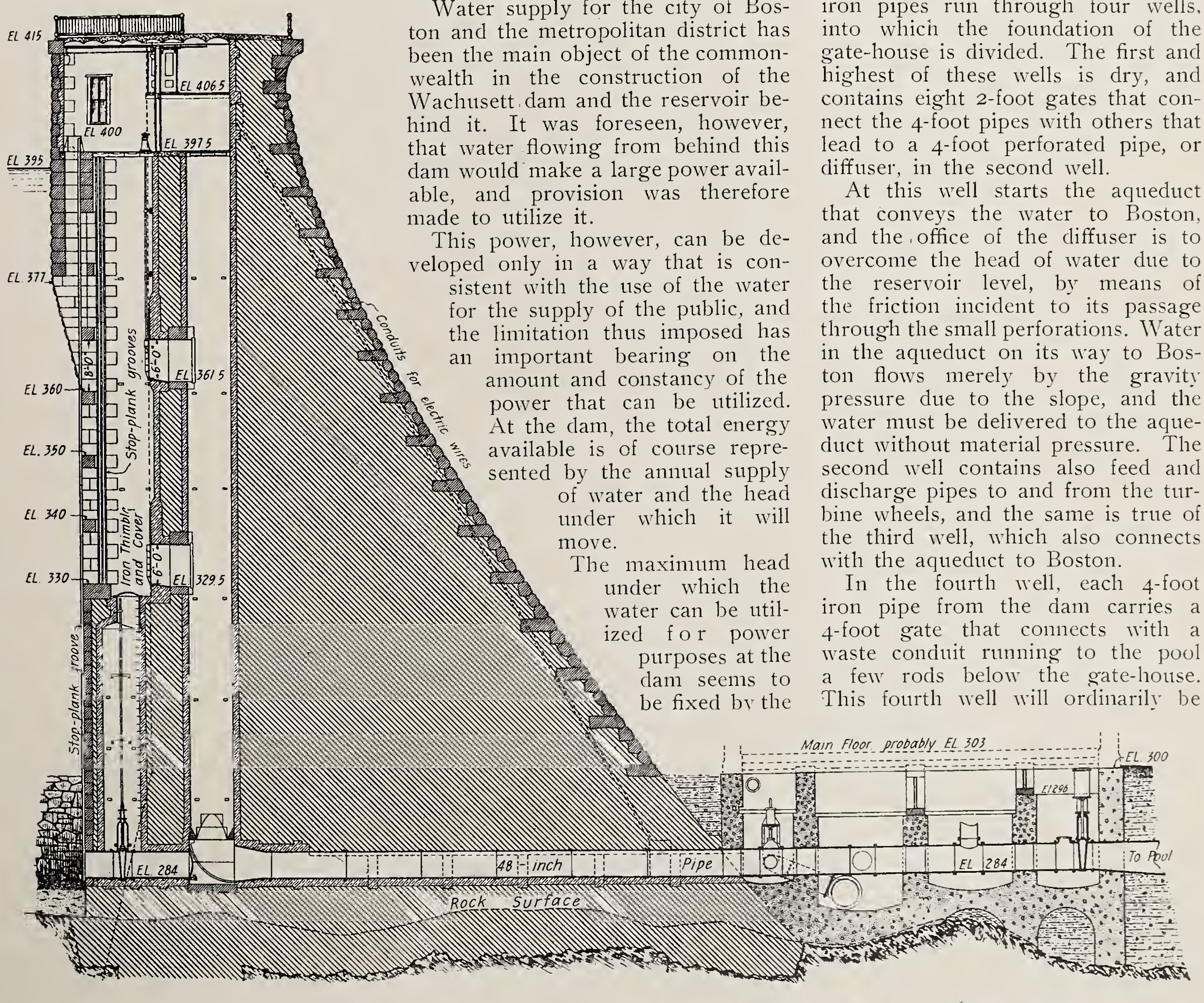
Water supply for the city of Boston and the metropolitan district has been the main object of the commonwealth in the construction of the Wachusett dam and the reservoir behind it. It was foreseen, however, that water flowing from behind this dam would make a large power available, and provision was therefore made to utilize it.

This power, however, can be developed only in a way that is consistent with the use of the water for the supply of the public, and the limitation thus imposed has an important bearing on the amount and constancy of the power that can be utilized. At the dam, the total energy available is of course represented by the annual supply of water and the head under which it will move.

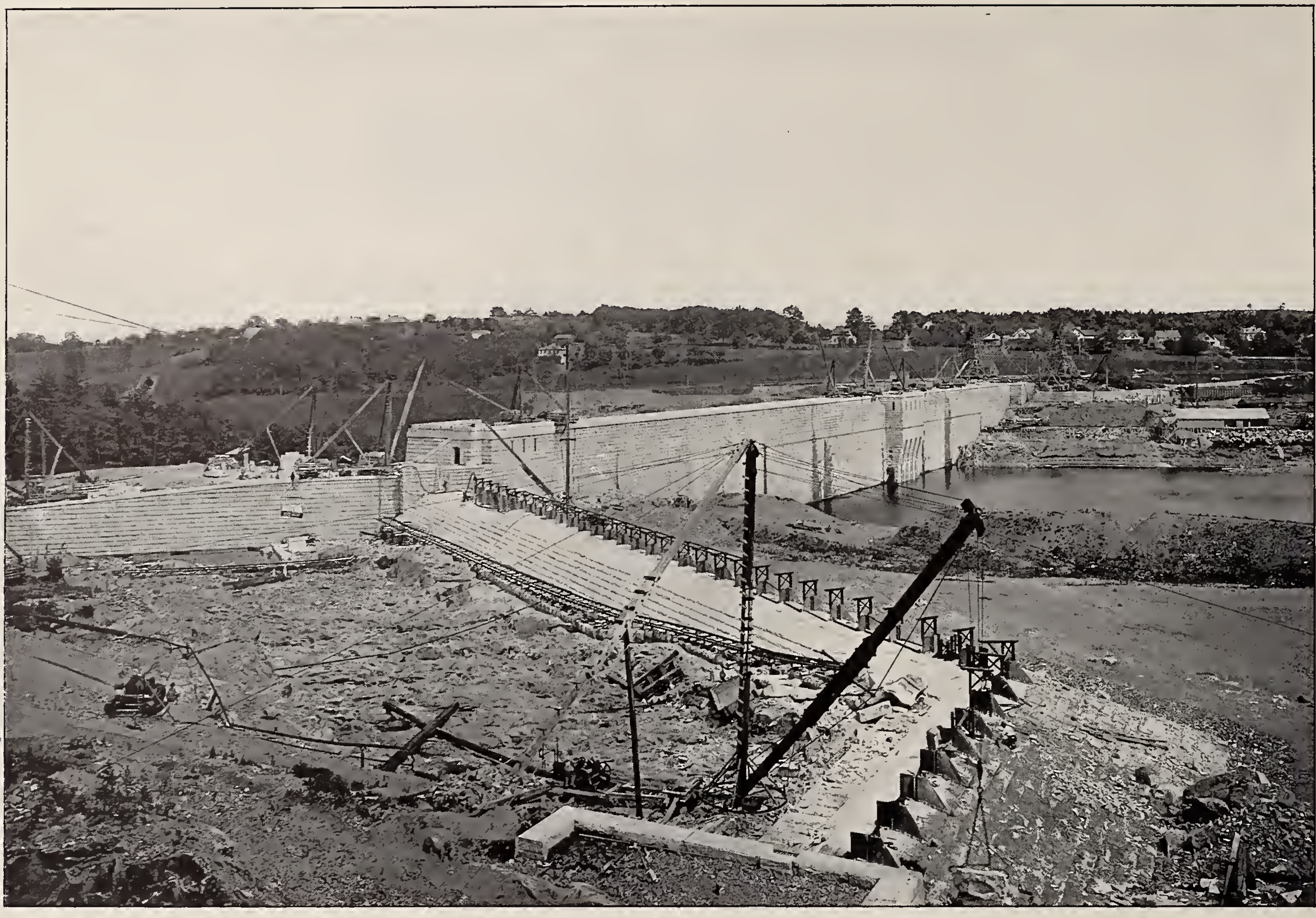
The maximum head under which the water can be utilized for power purposes at the dam seems to be fixed by the full-reservoir level, and by the center elevation of the pipes through which the water passes from behind the dam to the gate-house just in front of it. Four cast-iron pipes, each of 4 feet inside diameter, pass horizontally through the dam, with their centers at a common elevation 109 feet below the full-reservoir level, and enter the gate-house just below, where the turbines and electric generators are to be located. Beneath this gate-house the four iron pipes run through four wells, into which the foundation of the gate-house is divided. The first and highest of these wells is dry, and contains eight 2-foot gates that connect the 4-foot pipes with others that lead to a 4-foot perforated pipe, or diffuser, in the second well.

At this well starts the aqueduct that conveys the water to Boston, and the office of the diffuser is to overcome the head of water due to the reservoir level, by means of the friction incident to its passage through the small perforations. Water in the aqueduct on its way to Boston flows merely by the gravity pressure due to the slope, and the water must be delivered to the aqueduct without material pressure. The second well contains also feed and discharge pipes to and from the turbine wheels, and the same is true of the third well, which also connects with the aqueduct to Boston.

In the fourth well, each 4-foot iron pipe from the dam carries a 4-foot gate that connects with a waste conduit running to the pool a few rods below the gate-house. This fourth well will ordinarily be



SECTION THROUGH THE GATE CHAMBERS OF THE WACHUSETT DAM. ONE OF THE 4-FOOT PIPES IS SHOWN RUNNING THROUGH THE BOTTOM OF THE DAM TO THE GATE-HOUSE



A VIEW FROM THE WEST OF THE WACHUSETT DAM AT CLINTON, MASS., NOW IN COURSE OF CONSTRUCTION. NOT ONLY WILL THIS CREATE A RESERVOIR FOR THE PUBLIC WATER SUPPLY OF BOSTON, BUT ALSO PRODUCE A HEAD SUFFICIENT FOR THE GENERATION OF ELECTRIC POWER

dry, but if more water is discharged into the second and third wells than the aqueduct can carry away, the excess will flow into the fourth well and thence through two 5-foot pipes to the pool. This pool is located over the old bed of the river, and has a diameter of 55 feet in its central part, 150 feet at the outer rim, and an opening 110 feet wide on the down-stream side. Waste conduits from the 4-foot pipes and gates in the fourth well beneath the gate-house run to a space beneath the central part of the pool, and the openings in the bottom are so designed that the velocity of water discharged into it from behind the dam will be only about 4 feet per second.

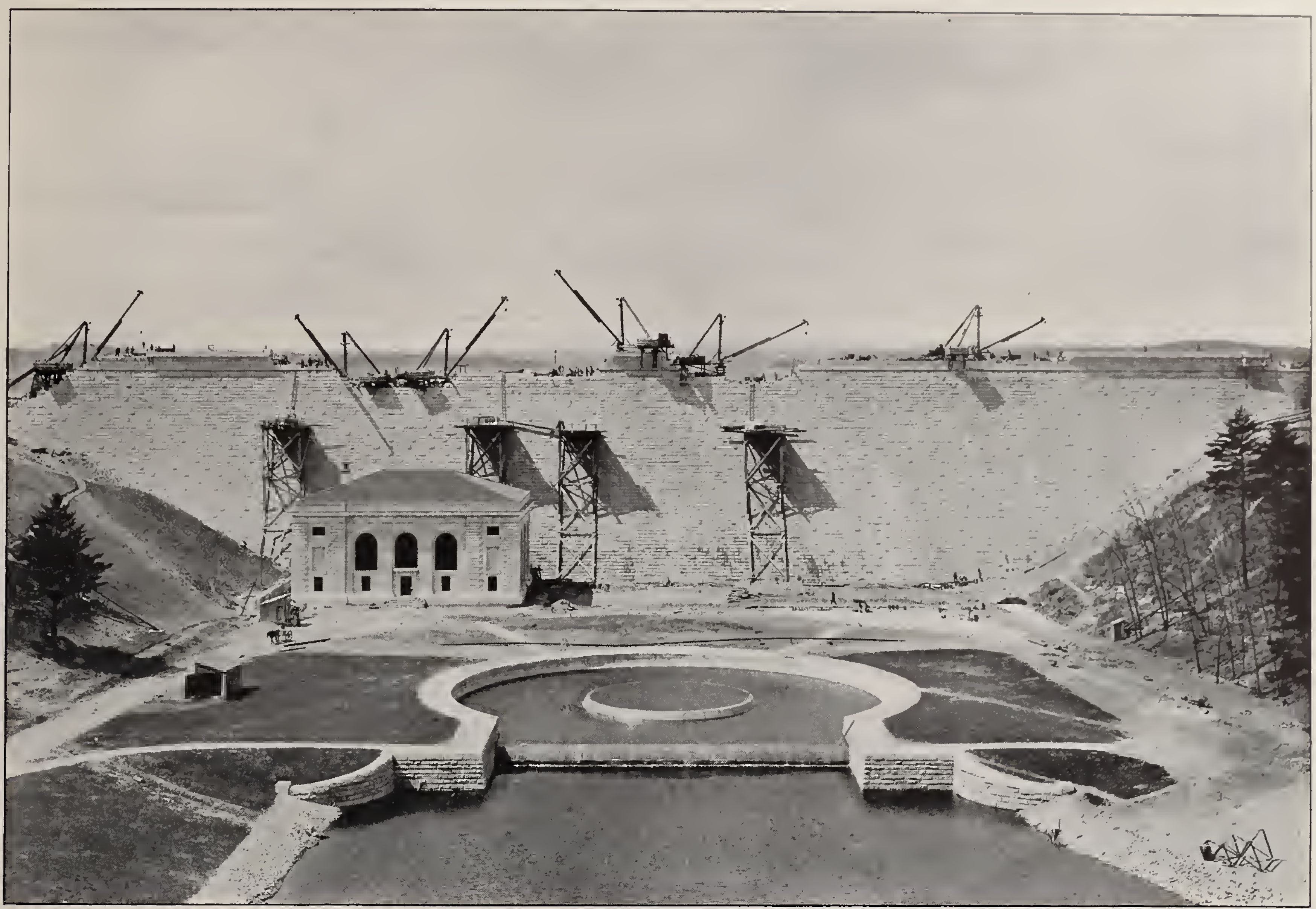
From the above construction it may be seen that water leaving the reservoir by way of the 4-foot pipes will either pass through the diffuser in the second well beneath the gate-house, and thence into the aqueduct that leads to Boston, or else will remain in the 4-foot pipes until the fourth well is reached, and then flow through the waste conduits to the pool, when no turbines are in use. In order to drive the electric generators in the gate-house, water from the 4-foot pipes will go through turbine wheels instead of into the diffuser, and, after being discharged from the turbines into the second and third wells, will enter the aqueduct for Boston.

If the turbines discharge more water than the aqueduct can carry, the excess will pass into the fourth well and then through the waste conduits to the pool. Evidently a proper adjustment of gates will add any desired amount of water from the diffuser to that which is discharged by the turbines, so that the aqueduct running to Boston may be constantly supplied.

In regular operation it is not the intention that water shall ever flow from the reservoir directly into the four 4-foot iron pipes that pierce the dam, though this can be done if desired; but before reaching these pipes the water passes through gate chambers in the dam itself. The lowest points in the gate openings to these chambers are 65 feet beneath the full-reservoir level, and 44 feet above the centers of the 4-foot pipes, so that in regular operation water will reach these pipes under a head of something more than 44 feet, at least. If the minimum reservoir level is taken at 1 foot above the bottom of the gate openings in the up-stream face of the dam, the minimum head of water entering the 4-foot pipes will be 45 feet, and as the head under full-reservoir level is 109 feet, the possible variation is 64 feet.

The extent of the variation of head will, of course, depend on the necessity of drawing down the reservoir level to meet the demands of the water supply system. During the year 1904, water from the Wachusett reservoir was used in the metropolitan system, and its surface level was 30.16 feet higher on June 1 than on March 1. On January 1, 1905, the reservoir level was 14.46 feet below that of the previous June. A part of this variation may have been due to the incomplete condition of the dam, for the highest level reached by the water on the first of any month was 63.54 feet below the elevation of the full reservoir surface.

In the Sudbury reservoir, which is a part of the same water supply system, the maximum change of surface level, as shown by the figures for the first of each month in 1904, was 9.02 feet from February 1 to



THE WACHUSETT DAM AS SEEN FROM THE VIADUCT. THE GATE-HOUSE IN WHICH THE TURBINES AND GENERATORS ARE TO BE LOCATED IS HERE SHOWN AND ALSO THE POOL CONNECTING WITH THE FOURTH WELL

June 1. As the Wachusett reservoir has a depth about twice as great as that of the Sudbury, it is to be expected that the changes of level will be much greater in the former than in the latter. While the amount of the variation in head of water at the Wachusett dam is thus uncertain, it seems probable that it will be sufficient to require some special provision for the purpose of maintaining constant speed of the turbine wheels and electric generators.

During the year of 1904, the quantity of water yielded by the Wachusett watershed was 122,011,000 gallons per day on an average. Of this total, 88,580,000 gallons went into the aqueduct for Boston; 26,156,000 were wasted into the riverbed below the dam, and 7,275,000 gallons were stored per day, on an average. The waste was due in large part to the incomplete condition of the dam.

A discharge of 122,011,000 gallons per day amounts to 1412 gallons, or 188.7 cubic feet per second. Under the maximum head maintained by the dam, namely, 109 feet, the discharge of 188.7 cubic feet of water per second develops about 2318 gross horse-power. As good turbine wheels and electric generators may readily be operated with a combined efficiency of 70 per cent., the average yield of the Wachusett watershed, in 1904, would have developed 1622 electric horse-power during 24 hours per day, under the head of 109 feet corresponding to full-reservoir level. The same daily discharge of water concentrated into 12 hours would yield 3244, or into 4 hours, 9732 electric horse-power. If the average daily discharge of water takes place in 4, instead of 24 hours, the discharge must be at the rate of 754 cubic feet per second, but this is less than the capacity of the four 4-foot cast-iron pipes through the dam.

These pipes, under the head of a nearly full reservoir, will discharge about 2500 cubic feet of water per second, and this will lower the reservoir only 1.25 feet per day, when no water is flowing into it. Between the Wachusett reservoir and the distributing pipes in the metropolitan district there are the Sudbury, Framingham, Weston, and several smaller reservoirs. These lower reservoirs make it possible to store water that may be drawn from Wachusett reservoir at a rapid rate during hours of maximum electric load, so long as the capacity of the Wachusett aqueduct is not exceeded. While the purpose to which this large power is to be devoted cannot now be stated, its development is causing much speculation.

New telephone instruments which can be used on telegraph wires have been supplied to the passenger crews of the Los Angeles division of the Southern Pacific Railroad Company, and these will be given a practical test. By means of these, employees of any train may be placed in direct communication with the dispatcher at the end of the division within two minutes after the train has been brought to a stop. The instrument is hung to the side walls of one of the cars and the connecting wires are brought in contact with the telegraph wire by an extension rod.

A commission has been appointed by the government of the Province of Ontario, Canada, to enquire into the hydro-electric power development, cost, and future possibilities in that province.

From the World's Technical Press

Heating by Electricity

IN an article contributed to "The Electrical Engineer," of London, by H. Allen, on electric heating as applied to soldering, brazing, welding, melting, etc., he says:—So far the electric current has not yet been exploited greatly in this direction, owing to the electric arc not being a suitable and convenient method for so many special cases, while the resistance method, when coils, etc., are brought into use as a heating medium, is subject to many inherent defects.

The resistance material called "Kryptol," consisting of a patented mixture partly composed of graphite, carborundum, silicates, and clay in a granular form, can, however, readily be handled by any ordinary skilled operator for such purposes as boiling, melting, etc., with electricity. The most simple form of apparatus for this purpose consists of a bed of refractory material having an electrode of carbon or other material at each end, to which the electric conducting wires are connected. These electrodes are situated some distance apart, according to the size of the bed, and the only further accessory that is required is Kryptol of proper sized granules to suit the available voltage of the current. If a quantity of Kryptol is spread, say, by means of a spoon, in a layer between the two electrodes, more or less current will pass through it in proportion to the thickness and width of the layer. For simply heating liquids, melting of lead solder and any metal of low melting point, the containing vessel may be simply laid on the granules of Kryptol. There are no regulating apparatus required to adjust the temperature, as all regulation is effected by manipulating the loose granules on the bed.

Supposing it was desired to weld two pieces of iron. In this case the pieces to be heated can simply be placed in the Kryptol, while by thinning down the layer, or making it narrower, the heat rapidly rises to any desired temperature up to about 3600 degrees F. Another feature about this material is that it is made in different-sized granules to suit the voltage, the usual range being from 100 volts to 250 volts. In a simple test the writer melted a cube of copper weighing 8.45 grm. in one minute. The metal was contained in a small porcelain crucible resting upon the Kryptol, which had been brought up to the required temperature. The electric supply was at 240 volts, and 15 amperes were applied. This may not seem very economical in regard to cost of current, but a short time only is required to raise the temperature to a welding heat, and the current can be shut off immediately the required temperature has been attained. Several different forms of stones have been designed for use as a bed for the material, but the simple flat stone is convenient for jewellers, dentists, chemical laboratories, etc.

Electrochemical Activity at Niagara Falls

ON August 26, 1895, the Niagara Falls works of the Pittsburg Reduction Company started operation. On October 19 of the same year the current was turned on at the plant of the Carborundum Company. Thus it is now just ten years, says the "Electrochemical and Metallurgical industry," since electrochemical activity started at Niagara, and in this short space of time more than a dozen varied electrochemical industries have grown up and are flourishing within a radius of 2 miles from the falls.

In electric furnaces at Niagara are made artificial graphite, siloxicon, silicon, carborundum, alundum, calcium carbide, phosphorus and various ferro-alloys. By electrolysis of fused electrolytes are made aluminium, sodium (for the production of various important derivatives), and caustic soda and chlorine. The latter two products are also made by electrolysis of aqueous solutions; while other products of such processes are caustic potash and hydrochloric acid and chlorates. The only example of a process using electric discharges through gases on a commercial scale at Niagara is the production of ozone for the manufacture of vanillin. As the latest developments may be mentioned that ground has recently been broken for the caustic soda and chlorine works, which will use the Townsend diaphragm cell, while in the old barn in which Mr. Rossi made his pioneer experiments on ferrotitanium, Mr. Ruthenburg's process of agglomerating in the electric furnace magnetic iron concentrates, now undergoes an experimental trial.

This is certainly a splendid development, and while as a necessary concomitant to the success achieved there have been commercial failures, yet their number is remarkably small. The most notable one is probably that of the Atmospheric Products Company, on the success of which very great hopes had been founded. When the company ceased operation, it was understood from a reliable source that the process was in a "relatively" better shape than ever before, but presumably not in such a shape as to warrant the expenditure of further capital. In the interest of the problem it is greatly to be regretted that no exact information on the causes of the failure has been published. Certainly, the problem itself cannot be considered to be dead forever.

The foundation of the success of Niagara Falls as a center of electrochemical industries is the cheap power and the geographical location. The cost of power is far less than in any steam-generated plant; nevertheless, it is not low enough to warrant,

for instance, the manufacture of ferrosilicon at Niagara in competition with some European producers. The advantages of the geographical location of Niagara are manifold:—Its location on the frontier of the United States and Canada, its easy accessibility by railways as well as by the waterway over the Great Lakes, with their 3600 miles of shore line and navigable to the very docks at Niagara.

Iron Mirrors for Galvanometers

A METHOD of producing light iron mirrors for galvanometers is described by V. Bierwicke in "Annalen der Physik." An iron strip capable of being electrically heated to redness is arranged in an air-tight glass vessel. Immediately over the strip is suspended the material (glass, mica, or celluloid) on which the mirror is to be deposited. The containing vessel is then highly exhausted by means of a mercury pump, and when a pressure of only a few thousandths of a millimetre is reached, the iron strip is raised to a bright red heat, and the deposition of iron commences. The deposit maintains its good reflecting qualities for a long period; it appears perfectly coherent under the microscope, and is capable of retaining a high degree of residual magnetism. In this way, the mirror can be employed as its own magnet in place of heavy cut-steel mirrors. The reflecting power of these mirrors for white light is about 62 per cent. of that of a silver mirror.

Utilizing Peat in New York State

ACCORDING to the "Engineering and Mining Journal," the first practical attempt to market the large deposits of peat found in the United States is now being made by the Peatkoal Company, of New York. It is working on a peat bog in New Rochelle, N. Y., close by the tracks of the New York, New Haven & Hartford Railroad's Harlem River division, and is disposing of its product as domestic fuel to the householders of the neighbourhood. The work is in charge of H. H. Weatherspoon, Jr., who has made a special study of the peat industry in Europe.

The company owns 5 acres of the bog and controls the remaining area, about 25 acres in all. The bog has an average depth of 27 feet, reaching 40 feet at the center of its area, and is entirely free from stumps or other obstructions. The peat is stated, with complete knowledge of European occurrences, to be superior in quality to that of any of the famous Bavarian localities.

The molding machine is the one designed and for 40 years improved upon by C. Schlickeysen, of Rixdorf-bei-Berlin, Germany. It consists essentially of a disintegrator, a macerator and a spiral propeller, by which the moist pulp is crowded through a brass-lined die, in three parallel square strands, which, emerging on removable boards, are cut by hand into blocks a foot long. These blocks are laid on level ground, and in two hours lose about 10 per cent. moisture, after which they are stacked and allowed to dry for about 18 days. The daily output ranges between 30 and 35 tons, at a total cost of $1.50 to $1.75 per ton, although lower figures have been reached.

The Inventiveness of Nations

IN dealing with the parts played by different nations in inventing, "The Engineer," of London, some time ago pointed out, as the first and most obvious fact in this respect, that English-speaking nations are far ahead of all other nations. The things done by France, Germany, Austria, Russia, Italy, and Spain are as nothing compared with the work done by the men of Great Britain and the United States.

A search for the reasons why some nations invent and others do not, would constitute a most attractive, even fascinating, inquiry. The German, it may be said, is far more receptive than originative. He lacks that peculiar type of imagination about which Tyndall has written with so much charm, and the absence of which is fatal to the spirit of mechanical exploration on which the art of invention depends. It used to be said that Americans could invent nothing but little things like apple parers and clocks. The statement is no longer quite true: yet the suggestive and interesting fact remains that the people of the United States are still far ahead, even of France or Switzerland, in the art of inventing small mechanism, such, for example, as the sewing machine, and machines used for making boots and shoes.

Germany, with a superb system of scientific education, apparently can originally invent nothing outside chemicals but a class of cheap commodities with which to undersell other nations. While it is not maintained that the scientific training is responsible for this, the evidence, which may be taken for what it is worth, is that Charlottenberg does not turn out men with epoch-making inventions seething in their brains.

So far as can be seen, indeed, it seems to be probable that in the future, as in the past, the progress of mankind will be due to genius far more than to education in any conceivable shape or form. To the end, the engineer will be, like the poet, born, not made; and this particular type of genius seems to be peculiar to English-speaking races. It is not in any way clear, moreover, that the education of the college or the technical school is in any way helpful to the man of original thought. As a matter of course he must be educated; but men of this type generally settle for themselves what their education shall be, and they will not care for orthodox methods of getting it.

The Care of Electrical Instruments

THE causes which produce 99 per cent. of the damage to instruments, says H. B. Taylor in "The Electric Journal," are usually an overload of one kind or another. Wattmeters and low-reading voltmeters suffer oftener than other instruments from the kind of mistakes which are least likely to be detected in an inspection of the connections. A wattmeter operating at low voltage, say one-tenth to one-fifth of its normal voltage, will have its series coil greatly overloaded before it shows a deflection as high as half-scale. Or, if the current in the series coil is small, the voltage across the shunt terminals might be raised so high that the shunt winding would burn out before the scale reading would indicate anything approaching an overload.

A voltmeter used in measuring the voltage across a highly inductive circuit, for instance, a direct-current voltmeter used in connection with an ammeter to measure the resistance of a transformer winding, may be damaged by the field discharge if the circuit is suddenly broken outside of the voltmeter connections. In a somewhat similar way, instruments connected to the armature of a machine may be injured if the field current is suddenly broken. These are examples of momentary overloads which are not likely to burn out the winding, but may bend the index or strain other movable parts.

When a wattmeter shunt or voltmeter is connected across part of a circuit in which the line voltage is higher than the maximum range of the instrument, it is important that the part of the circuit between the

instrument terminals shall not be broken while the instrument is connected. To do so would, in most cases, practically place the total line voltage across the meter. Disconnecting a series instrument while the shunt instruments are connected to the line side of it is a common cause of such accidents.

There is no good way of protecting voltmeters against sudden great overloads; the probability of injury can be reduced by keeping them disconnected at all times when readings are not being taken. Series instruments can be protected to some extent by having switches arranged to short-circuit them, the switch being opened only when a reading is to be taken. Fuses or circuit breakers can be used to prevent the winding from being actually burned out, but they cannot prevent the mechanical shock to moving parts due to sudden overloads. With series instruments having considerable resistance, the short-circuiting switch may not be applicable, especially if the voltage of the circuit is low. If the current were adjusted with the instrument in circuit, the short-circuiting of its resistance might cause an undesirable rise of current.

A very common practice, which is detrimental to the pivot of instruments which have carrying cases separate from the meters themselves, is the habit of standing the box with its opening at the top and dropping the meter into it instead of laying the box on its side and sliding the meter in.

Electrical Resistance of Steel

A RECENT issue of the "Bulletin" of the Société d'Encouragement pour l'Industrie Nationale contains a short but interesting article upon the "Electrical Resistance of Steel," to which attention is called by "The Engineer," of London. Following up some experiments made some time ago by Monsieur H. Le Chatelier, the author of this article—Monsieur P. Mahler—has carried out a series of tests on specimens of steel containing varying amounts of carbon, manganese, sulphur, phosphorus and silicon.

Generally speaking, he has established the fact—which in truth is what might have been expected—that the more impure the steel, the higher is its electrical resistance. For example, in one of his sets of experiments he took five test pieces, varying from soft steel, with a breaking stress of 40 kilos. per square millimeter of cross section, to hard steel with a breaking stress of 70 kilos. The percentage of carbon varied from 0.16 per cent. to 0.62 per cent., and of manganese from 0.70 per cent. to 0.80 per cent. The observed resistance was 14.6 microhm-centimeters for the soft steel and 18.0 microhm-centimeters for the hard steel. M. Mahler found that the total resistance varied in accordance with the formula $R = 10 + 7C + 5Mn$; where C is the carbon, Mn the manganese, and 10 the resistance due to the iron and to the other impurities, such as sulphur, phosphorus, etc. The 7 and the 5 for carbon and manganese were the figures which M. Le Chatelier had found in his experiments. The coefficient 10 has been found by M. Mahler, and within the limits of his investigations the formula appears to give the resistance of any steel of known composition very nearly.

There are discrepancies, which are sometimes on one side and sometimes on the other, but in a number of cases the calculated resistance was found to be the same as that which was obtained by measurement. Perhaps the balance lies rather in the direction of the coefficient 10 being somewhat high; but this error is certainly on the right side. The ability to estimate the electrical resistance of steels of known composition within a reasonable degree of accuracy is highly important, having regard to the increasing use of steel rails for conducting electricity, and it would appear that in samples of metal known to be more or less oxidized or more or less gaseous, the actual resistance is less than what might be looked for if the above formula is taken as a basis. This means that, at any rate, the probabilities are that a calculation of the resistance is more likely to err on the high than on the low side.

The Fuel Value of Ashes

ACCORDING to "The Engineering Record," the fuel value of ashes from four typical boiler plants in New York, the mechanical plant of the Rogers Building, the Edison Electric Light Company, the Hotel Berkeley and a large packing house where mechanical stokers are used, have been investigated by Messrs. H. Fay and F. W. Snow, of the Massachusetts Institute of Technology. The ashes, all from bituminous coal, were first screened into three classes of material, each of which was sampled by crushing and quartering. The samples were then mixed with a known amount of standard coal to promote combustion and tested in a Mahler bomb. The average percentage of unburned coal in each of the four ashes was 2.49, 19.2, 6.66 and 18.6, respectively. The average, 11.98, is considerably lower than that ordinary assumed for New York ashes.

Electric Power from Blast Furnaces

A CONTRIBUTOR to "The Iron Age," writing on the above subject, says, regarding the advantages of engines driven by blast furnace gas, that there is no waste in coal, no waste in water, no dust nuisance from iron ores, no nuisance from smoke, no escaping steam, no steam engine, no smokestack at all, no boiler explosion danger, and no boilers. That in cities with convenient harbour equipments like New York or Philadedphia, a big coke oven plant, blast furnaces, or a steel plant may become a desirable industry in the future, since it would be coupled with less dust and smoke troubles than any large city power and light plant, skyscraper building or illuminating gas works. Gas engines driven by blast furnace gas have now been in successful operation in Germany more than ten years.

The main point in regard to the construction as well as concerning the management of such a big gas producer as a blast-furnace plant may be considered as follows:—The complete plant may be based to-day on selling electricity and obtaining as main by-products coke (with its auxiliary by-products, sulphate of ammonia, benzol, sal ammoniac, tar and naphtha), pig iron (with its auxiliary by-products, slag cement, bricks and heating gas) and steel, if desired. As the installation of gas engines instead of steam motors is the most important matter, therefore the apparatus for gas manufacturing, such as the coke ovens and blast furnaces, must be constructed with reference to the most favourable conditions for the operation of the gas engines. The coke ovens as well as the blast furnaces should be provided with a charging mechanism, which works as continuously as possible, because the thermal efficiency of the gas engine depends upon the regular and continuously uniform quality of the gas. The financial efficiency of the plant depends also upon the gas engine, as the latter produces the main product —namely, electricity.

A blast-furnace plant in New York would be based on a supply of iron ores shipped from the lake harbours to the plant by water from Buffalo. Other sources would be Canada,

Spain, etc., by the Atlantic Ocean. The fuel supply may be based on direct coke contracts or on shipments of coal from Pennsylvania, Virginia, etc. The latter method may be preferred, as the power from the coke oven gas is secured and the other by-products are made right in the market. Thus, starting with the coke ovens, an approximate calculation is as follows:—

Of coal, 11,000 tons yield 10,000 tons of dry coal or are converted into 7850 tons of coke; the balance on an average consists of 120 tons of ash, 110 tons of sulphate of ammonia, 100 tons of tar, 30 tons of pitch, 60 tons of benzol, 5 tons of naphtha and 2 tons of sal ammoniac, or about 8250 tons of products out of 10,000 tons of dry coal. There is also produced 1600 tons of coke oven gas from which it is desirable to earn profits. If such a complete plant belonged to the municipality the city would have its own required electricity free of cost.

Practice has proved that 1 ton of coal is equivalent to 10,000 cubic feet of such gas, or even more. The heating value is nearly the same as that of city gas, averaging, say, 600 British thermal units per cubic foot. Many gas engines will yield 1 H. P. for 10,000 British thermal units, but, conservatively, 12,000 British thermal units may be taken in this calculation, making each horse-power require only 20 cubic feet of coke oven gas per horse-power per hour. Of the gas made 50 per cent. is used for heating the ovens, and if a further loss is allowed of 10 per cent. of the gas for uncontrollable leakage, or for engines running under less favourable conditions, then 4000 cubic feet of gas is available for power, or 200 H. P. for each ton of coal.

One ton of pig iron requires an everage of 1 ton of coke and 2 tons of iron ore. With one furnace of 576 tons daily output especially designed as a gas producer for the subsequent generation of electricity through gas engines, the power expressed in electricity which is daily obtainable is as follows:—

	Cu. Ft.	Cu. Ft.
Blast furnace gas		3,600,000
Less:—		
Blast heating gas	900,000	
Blowing engine gas	400,000	
Furnace loss	180,000	
Cleaning gas	252,000	
Power gas (auxiliaries)	115,200	
		1,847,200
Remaining for further utilization		1,752,800

The gas thus remaining when converted into electric power by gas engines gives 17,528 H. P. on the brake and, allowing 10 per cent. loss for efficiency in the electric generators and transformers, 17,528 — 1752 = 15,776 electrical horse-power, equivalent to approximately 11,760 KW.

It is now only a few years (1896-1897) since pig iron was placed on the New York market at $10.50 to $12 a ton. It is to be hoped that such times will not come again, but they should be remembered in considering the basic costs. The price of coke in large quantities delivered in the bins may be placed at $3.50 per net ton. Iron ore under various conditions may be had at $2.50 per ton; adding for lime, repairs, labour, etc., and maintenance another $3.50, brings the cost of pig iron up to $12 per ton, assuming that the plant is valueless after ten years. The cost per kilowatt is obtained on the basis of 24 tons of pig iron per hour, producing 11,760 KW. One ton of pig iron is thus equal to 490 KW., and as each ton costs $12, 1 KW. costs 2½ cents to produce.

Theoretically, it may be said that pig iron is a by-product of the new improved gas producer, fired with coke and charged with iron ore as a flux for the ash and clinkers. The latter are melted down, however, thus avoiding the stoking, and characterizing the blast furnace as the best gas producer of larger size. The connection of a steel plant is desirable, because in it the coke oven gas may be used either pure or mixed with the blast furnace gas for heating the various melting and heating furnaces. The boiler is then entirely avoided, as all rolling mill engines run on gas, all auxiliary machines with electricity, and no other coal is supplied than may be required for the manufacturing of the coke for the blast furnace. This would constitute an electric plant using only plain coking coal and iron ore for power.

Making Alloys Without Fusion

ACCORDING to "The Electrical Engineer," of London, a demonstration was recently given by Mr. Sherard Cowper-Coles at London of his low-temperature process for making alloys without fusing any of the metals.

If a copper plate be surrounded with zinc dust and heated to 500 degrees F. for about an hour, he has found that the two metals unite, and the plate becomes covered with a film of zinc, even though the temperature has never been within 200 degrees of the melting-point of the latter metal. The surface of the plate becomes hardened to such an extent that it cannot be readily scratched. In the same way iron and steel articles can be covered with a uniform homogeneous layer of zinc, and, in fact, galvanized, though the advantage is claimed for this process over that of ordinary galvanizing that the temperature employed being much lower, the temper of steel articles is not impaired.

Objects treated by this process must be free from scale, but red dust does not matter, while grease seems to be rather an advantage, so that machine work, such as bolts, nuts, and screws, may be subjected to the Sherardizing process immediately after being machined, without preliminary preparation. On a large scale the operation is carried out by packing the articles to be treated in an iron drum full of zinc dust, and heated; preferably this drum should be airtight and exhausted of air to prevent formation of too much zinc oxide, or, alternatively, about 3 per cent. of carbon in a fine state of division may be added to the zinc dust.

Chain-Making by Electric Welding

IT is only recently that welding by electric current has been employed in chain manufacture The process first secured recognition in Germany, France, Belgium, Russia, Italy and Sweden before it was experimented with in America. "The Iron Age," in contrasting this new process with the present method of making chain on gas fires, says that in the latter method there is a great deal of heat wasted, and an examination of a large number of links in a common chain welded in a gas forge showed less than half of the welds to be perfect. One of the main reasons for the imperfect welds is the way in which the link is scarfed. The thin part cools more rapidly than does the body of the scarf and loses its welding heat before the weld is made, with the result that the ends of the scarf are not welded, but merely pounded together.

Tests of chains welded at the end of the link show that 75 per cent. or more break at the weld, due to imperfect welding. A perfect link welded at the side where the wear and strain are the least has shown tensile strength equal to 80 per cent. of the double bar of the material used. It is thus that a chain is formed and welded in the Giraud electrical process.

In forming and cutting chain links by the Giraud process a bending machine is used which is entirely automatic in its operation. The coil of stock is placed on the reel and the end started through the straighten-

ing rolls into the feeding mechanism of the machine, after which it is cut and bent automatically into links of uniform dimensions. Each new length of stock is passed through the last completed link and bent in that position, so that the links issue from the machine assembled in a continuous chain. The weld is made on the side of the link instead of on the end, as in the old process, and the ends instead of being scarfed at an angle of 60 degrees are cut square and left about 1-16 inch apart ready for butt welding.

On the bending machine 20,000 links of 9-32-inch stock can be cut and wound in one day, 5 H. P. being required for driving. The links being ready to weld are fed into the welding machine. The chain is passed through the machine twice, as only alternate links can be welded at each passage without revolving the entire chain 90 degrees about its axis for each succeeding link. In the machine each link to be welded is brought in contact with two electrodes, one on either side of the split in the link, and current is passed until a welding heat is reached. Meantime, slides carrying dies adapted to engage the ends of the link, press the joint together. After the weld has been effected and while the metal is still hot a spring-actuated hammer, having a semi-cylindrical groove in its face, strikes the link against an anvil with a correspondingly grooved face. This removes the fin formed during welding and finishes the surface. These machines are made both automatic and non-automatic. The best work is performed on a non-automatic machine, which may be operated by unskilled labour.

The first and most important consideration in any welding process is the certainty of securing a perfect weld. In the Giraud welders the link is firmly secured in the welding clamps in full view of the operator. As the current is applied the ends of the link may be watched while they come to the proper heat, and the current can be cut off at the right moment. There is therefore no waste heat, as the heating does not commence until the ends are in contact, and when the weld is made the current is cut off.

A link heated in a fire is heated from the exterior inwardly; consequently the outer surface reaches the welding heat first. It is often the case that when the appearance of the link would indicate that the proper heat had been reached it is in reality heated insufficiently in the interior, so that when a weld is attempted it will stick together only on the edges. In electric welding, on the other hand, the heat is developed first in the interior and makes its way out, so that when the usual white sparks are emitted it is known that the entire joint is heated to the welding heat.

The heated portion of the link to be welded is not exposed to the air, as in the fire-welding process where oxidizing occurs, forming scale that often prevents a perfect weld. The act of forcing the abutting ends together in electric welding causes the current to flow, rapidly bringing the ends to the welding heat. There is no noise, no dirt, no intense heat to contend with, no waste due to overheated or imperfectly welded links and no dependence on skilled labour.

With electric welding perfect homogeneity is secured. Tests show that the conductivity of the weld is just the same as that of the body of the material and in some cases actually higher.

There are several fixed costs in chain manufacture, including cost of material, cost of welding and cost of fuel. Cost of material depends on the market price of rods, which at the present time is about $36 per gross ton, or $1.60 per 100 pounds. The item of 10 per cent. waste covers the average waste of material in winding, cutting and welding. In the new process there is practically no waste, owing to the improved method of winding and cutting and the welding by electric current. The item of cost of welding is a fixed price per 100 pounds, determined by the Chain Makers' Union. For the smaller sizes of chains the price is fixed so that the workmen may easily make from $2.50 to $3 per day, while on the larger sizes requiring more exertion in handling a higher daily wage is averaged.

The item of fuel depends on the cost of coke, gas or oil, that for coke being lower than that for gas, although lower daily average production results, while oil is slightly more expensive than gas. A double gas fire burns about 6000 cubic feet of gas per day, which, at 15 cents per thousand, makes the average daily expense per fire 45 cents.

The item of daily expense will vary according to the size of the plant and its daily production and is intended to cover all expenses not otherwise included in the cost estimate, as, for example, all expense of handling material, testing chain, running the plant, providing power for operating hammers, winders, cutters and blast fan; office expenses, such as salaries, advertising, all selling expenses, repairs to machinery, taxes, interest on investments, etc. It is commonly assumed to be one-half of the daily welding cost, therefore varies with the size of chain figured on. It averages about $1.40 per day, but on large sizes of chain, where the welding cost is from $5 to $10 per day, the allowance for expense will be greater.

Assuming the expense in operating an electric welding plant for the manufacture of chain on the same basis—namely, one-half of the daily welding cost—a comparison of the estimated costs of production of the three grades of chain—common, steel loading and block chain—on gas fires with that of the same size chain made by the Giraud process will show a decided advantage in favour of the latter.

Electric Shock Fatality

IN "The Electrical Review," of London, is reported an inquest into the death of an electrician, which occurred while he was engaged at work adding an extra light in the basement of some premises at Kennington Lane where an installation had just been completed. His partner, who gave evidence, said that he went to remind the deceased, who was his brother-in-law, that it was dinner time, when he saw him fall dead. The victim had a pair of pliers in his hand with the end of a wire in them. The current was supplied by the South London Electric Supply Corporation, at 220 volts. He did not think that the current in itself would be sufficient to cause death; 220 volts was supposed to be safe for ordinary purposes. The deceased had always been nervous about receiving a shock, and possibly fright affected him. He thought the accident was due to the fact that his brother-in-law was standing on damp earth, which formed the floor of the basement, and that the nails in his boots had something to do with it. It was customary to cut the current off before commencing work, but it was not done in this case. He went on to say that under similar circumstances he had been able to release his hold of the pliers when the voltage had been as high as in this case, but the current was apt to take away one's power to a certain extent,—it depended on a person's constitution.

It was certified that death was due to an electric shock of a continuous kind, which caused rigidity of the muscles and arrest of respiration, and also stated that death was not instantaneous, but slow.

The home office inspector gave

evidence respecting the possibility of releasing one's hold of a "live" wire. Experiments by a Continental professor with alternating currents showed that the point at which he could not release his grip was 96 volts. It might happen with a current in domestic use, as in this case, that a man would not be able to let go, but in the ordinary way the risk did not exist, as there was nothing but properly insulated parts to come in contact with the hand. This accident occurred through disregard of two elementary rules. Notice should have been given to the supply company, and the current should have been cut off before work was commenced. The jury returned a verdict of "accidental death."

Train Dispatching by Telephone

THE Baltimore & Ohio Railroad claims the distinction of being the first steam railroad to systematize the use of the telephone for the movement of trains. It is stated in "Railway and Locomotive Engineering" that a conference of the dispatching staff was held recently, in Baltimore, and a set of rules and forms prepared so as to reduce the method of handling trains by telephone to a standard. Every non-telegraph station that has a passing siding is to be fitted up with a telephone connection to the nearest telegraph office. This will enable the transmission of train orders from the telegraph office to the train crews at these sidings, or to an employee stationed there for that purpose.

For some time the Baltimore & Ohio Railroad has been extending the use of the telephone for the transmission of ordinary business messages, connecting the division headquarters with the terminals of the divisions by means of the "composite" telephone method. This system admits of the simultaneous working of the wires telephonically and telegraphically without interfering with each other.

In addition to these long circuits, the telephone is used extensively in single-track blocking, for the movement of yard engines, and the connection of non-telegraph stations with telegraph stations. In this manner the telephone is used for single-track blocking between Newark and Bellaire, Ohio.

The telegraph offices average about 8 miles apart, and at many points the siding extends beyond the telegraph office a distance of about 2 miles. By having telephones located at the switches, a train may be allowed to use the passing siding up to the outlet switch. Then as soon as the train for which it has been held has passed, the conductor notifies the operator in the block signal tower and he is given permission to proceed with his train to the next block signal office. In this way the blocks are practically cut down so far as main track use is concerned, just so much as the side tracks extend into the blocks. In some instances it permits of the use of 4 miles of passing tracks, leaving but 4 miles of main track to be covered by the blocking.

The result is that the telephone practically shortens the block by one-half the distance and hastens the movement of traffic to that extent. This method of using the telephone between Newark and Bellaire, over 104 miles of single track, has been in use for about two and a half years with great success. It is a system that very much facilitates the handling of traffic and is perfectly safe in the movement of trains.

Double-Filament Telephone Lamps

THE employment of incandescent electric lamps for telephone signaling purposes in exchanges has a disadvantage, says "The Electrical Engineer," of London, in that the failure of a lamp cannot at once be detected, since but one control lamp is provided for each group of lamps.

To insure that a call signal attracts notice at the switchboard, notwithstanding the failure of a particular lamp, special control relays are now generally provided with resistance for inserting automatically in parallel with the lamps. These relays serve to switch in the lamp which controls a large number of call lamps, as soon as a call is made. But such an arrangement is also subject to a disadvantage in that the failure of a lamp can be immediately detected only when there is no second call at the moment. Moreover, the control lamps show that a lamp is defective, but do not indicate which—hence loss of time in testing, with consequent disturbance of the service.

In order to avoid these objections a new lamp has been designed. This lamp combines in itself the call and control signals. It is novel in that, instead of a separate resistance for switching in parallel, the lamp contains a second filament, which is not noticeable so long as the principal filament remains intact. The auxiliary filament is of higher resistance than the principal filament, and consequently has a longer life. Should the illuminating filament break, the auxiliary filament assumes a dull red glow, thus indicating the defect. The watt consumption of the lamp is the same as for the ordinary type of carbon-filament lamp, plus the loss in the auxiliary filament.

Electric Haulage on the Teltow Canal in Germany

ACCORDING to "The Electrical Review," of London, the works in connection with the construction of the Teltow Canal, in Germany, which will have a total length of 23 miles, with only one lock, are approaching completion, and it is expected that the undertaking will be brought into use before the end of the year. Already, the power station which is to supply electrical energy for the working of the lock gates and incidental machinery, and also for the operation of the electric locomotives running on rails along the sides of the canal for the towing of boats, is nearly finished and equipped with boilers and two 850-H. P. steam turbines and electrical generators, the latter of which are now furnishing current for the experimental working of the lock.

The track for the locomotives on the entire eastern section has been laid on both sides, while the rails and standards for the overhead wires have been partly placed in position on the western section. It is anticipated that only 15 minutes will be occupied in the clearance of the single lock, calculated from the time of arrival to that of departure, the average difference in the level between one section and the other being 10 feet. The haulage speed of the boats will be comparatively high in consequence of the almost entire absence of locks. The district at the western end of the canal is expected to be developed as a pleasure resort.

According to "The Engineer," of London, there is a strong tendency in Germany to abandon conduit and accumulator systems in favour of the overhead trolley throughout for street railways, principally for reasons of economy. Mixed working by trolley and accumulator cars is retained only in Dresden, while trolley working in conjunction with sections of conduit line exists in Berlin, Dresden and Düsseldorf. The reliability of the conduit system, as compared with that of the overhead trolley line, leaves much to be desired, according to German experience.

THE ELECTRICAL AGE

Volume XXXV Number 3
$2.50 a year ; 25 cents a copy

New York, September, 1905

The Electrical Age Co.
New York and London

ESTABLISHED 1883

Published monthly at 3, 5 and 7 W. 29th Street, New York City.
Telephone No. 1617 and 1618 Madison Square. Private branch exchange connecting all departments. Cable Address—Revolvable, New York.

SUBSCRIPTION RATES

The Electrical Age will be sent post free anywhere in the United States and its possessions, Canada and Mexico for $2.50 per year, single copies 25 cents. To Great Britain and all countries embraced in the postal union, $5.00, 20 shillings, 25 francs, 20 marks, or 15 rupees. Send subscriptions to our nearest branch office or agency.

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Insertion of new advertisements or changes of copy cannot be guaranteed for the following issue if received later than the 15th of each month.

LONDON OFFICES

Business Department, 33, Bedford Street. Editorial Department, 22, Henrietta Street. Covent Garden, Strand, W. C.

London Telephone, Post Office, 3807 Central. Private branch exchange. London Cable Address—Revolvable, London.
All remittances to London Office should be crossed London and County Banking Company.

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Leading Articles

Lightning Accidents

If a complete record should be obtained of the actual number of people, buildings, and barns that are struck by lightning every summer in all parts of this country alone, the result would probably be astounding. A very incompletely kept record, for instance, shows that lightning shattered over twenty flag poles within a radius of eight miles from the New York City Hall during the month of July, 1905. A record kept by the fire marshal of Ohio, of the lightning accidents reported in only one-third of the newspapers of that State, for ninety days of this summer, shows that 332 serious lightning accidents occurred. By these accidents nineteen people were killed and 100 were stunned. Forty-seven houses were struck, of which eight were set on fire. One hundred and eighty-four barns were struck, of which 166 were totally destroyed by fire. Probably these figures do not embrace one-half of the total number of accidents due to lightning in that State alone during the time stated.

The question of how best to obtain immunity from the losses due to lightning is one of the gravest that now confronts the fire underwriters of this and other countries, and notwithstanding that these interests have able men at work upon the best solution of the problem, there is little doubt that the advice and co-operation of electrical engineers and competent inventors toward that end would be gratefully received. Indeed, such advice and co-operation are invited.

And yet the remedy for these accidents may not be as difficult to find as it appears. The greatest difficulty may consist in the application of the remedy. The statistics of fire insurance show that the claims for losses on perfectly rodded buildings are rare, and also that lightning seldom causes losses in buildings that are provided with metal roofs and well grounded metal leaders. These statistics are certainly suggestive.

It is known that of recent years the rodding of buildings in country places as a protection against lightning has fallen into general disuse, because of a prevailing opinion that the rods are of no practical utility. This, however, may easily be an erroneous view of the matter, and if one may judge from the evident lack of skilled attention in the manner of construction, the quality and type of metal used in the existing rods, and the neglect to keep the rods in proper connection with the ground after a few years of service, innumerable instances of which neglect are observable in any farming district, as well as in the cities, a reason for the failure of the lightning rods in many instances to protect the buildings will not be far to seek.

Admitting this, however, it may at the same time be remarked, in view of the great advances made during the past fifteen or twenty years in our knowledge of electric surges and oscillations, that there is no doubt that a thorough examination of the subject by experts with the object of pointing out to practical laymen the best modern methods of lightning protection, will prove of incalculable value.

American Enterprise in the Philippines

Every now and then the country is reminded of the responsibilities which are incumbent upon it through its continued possession of the Philippine Islands. The national problem which the Archipelago and the welfare of its inhabitants present, demands close study and careful treatment on the part of the government. Thus far, the results accomplished have in a great measure demonstrated that America can as successfully administer the affairs of its colonial possessions as can any of the older world powers. Great Britain is undoubtedly foremost and most successful in matters affecting and relating to colonization projects, but the progress made by America in the few ventures upon which it has embarked has inspired confidence in the ability of the country to successfully carry out such work. This was not anticipated prior to the war with Spain in 1898.

Already, through the active government co-operation, American cap-

ital has done much towards improving conditions in Manila and the other principal Philippine towns, and it is fair to say that the Archipelago, as a whole, to-day presents to the visitor a strikingly different set of conditions from those which existed during the several hundred years of Spanish occupation.

It is not possible here to trace the betterments in allied lines, but in matters more closely associated with the field of electricity, we have taken especial pains to make a study of what is going on. In this issue we print an article relating to the recently completed electrification of the tramway system of the city of Manila. Probably nothing has done more for the city in stimulating the interest of its inhabitants in American methods than the inauguration of this system. It has been accepted with great enthusiasm by the natives, and from the first has been an eminently profitable undertaking. The road was built and equipped by one of the foremost American contracting firms, and one which has probably as broad, if not broader, international connections and interests than any other American business establishment. The spirit which animates this organization and which tends to broaden the scope of its international influence can well be studied and emulated by other interests, as all undertakings of this kind tend to increase American prestige abroad and help directly towards the future commercial welfare of the country.

Isolated Plant Switch Boards

In the examination of an isolated plant the switchboard is always an interesting part of the equipment, because at that point the entire electrical output of the installation is concentrated, measured, and controlled. At the present time, striking differences in design exist among such switchboards, which vary from the most elaborate to the simplest layout, often with little apparent reason. Although it is out of the question to draw up a switchboard specification which will meet the needs of various installations in detail, it is certainly worth while to obtain a clearer idea of the general requirements of the work.

Comparing the modern switchboard with that of the earlier days, a marvelous improvement in mechanical arrangement and workmanship is at once apparent. As a finished production the switchboard of to-day is often a work of surpassing beauty, both in its appearance and constructive details. At the same time the design frequently involves much needless expense and bears little relation to operating convenience. Superfluous and expensive equipment often finds a place upon the panels. It is well to bear in mind that a switchboard has two functions, measurement and control of the output, and that the operating economy of the plant is considerably dependent upon the design and installation of the equipment adopted.

Many isolated plants have been placed in service without any arrangement for recording or indicating the total generator output. It is well in this respect to take a hint from the direct-current railway switchboard and place a totalizing panel between the generator and feeder bus-bars. If this be done, the necessity of individual recording wattmeters for each generator panel is obviated and the first cost is in many cases notably reduced.

It is of great importance in the majority of plants running under modern conditions to keep an eye from month to month upon the cost of operation per kilowatt-hour at the switchboard, and an installation without one or more recording wattmeters is a rudderless ship indeed. Rarely does one care to know the integrated energy output of the individual generating units in a plant; what is wanted is the total figure for the installation. In prorating the different items which make up the cost of operation, the totalizing panel is of great service, and its simplicity particularly commends it to those who wish to rid themselves of needless instrumental readings and computations.

Good practice requires an ammeter for each generator panel, and a station voltmeter is, of course, a necessity. A second voltmeter, with connections for plugging it into any generator, is of equal importance, and this ends the list of vitally essential instruments, unless we except a totalizing ammeter. The station voltmeter may readily be of the recording type if desired, and there is much to commend in the practice of installing it with a recording ammeter upon the totalizing panel. In some cases it is desirable to equip the feeder panels with ammeters or wattmeters, possibly both, but in general isolated-plant service where special arrangements are not needed for measuring the light and power consumed by tenants, there is no doubt that this is a good place in which to economize. It is not uncommon to find switchboards loaded down with instruments which are rarely used by the attendants, and there is certainly little excuse for paying money for equipment unless it can be shown to be necessary to the convenient and economical operation of the plant.

It is a question if the advantages of recording ammeters and voltmeters are as widely appreciated as is desirable. In many plants an attempt is made to estimate the output and variations by hourly or half-hourly readings of the indicating instruments. This is always burdensome and calls for a large amount of clerical work in the course of a year. The usefulness of a complete automatic record of the current and voltage variation is beyond question when the performance of the plant is analyzed. When extensions or consolidations are contemplated, the existence of continuous daily records is a great help to the consulting engineer, and in many instances saves the time and expense of making test readings over a protracted period. There is nothing like an automatic load curve to exhibit the 24-hour performance of a given installation in commercial operation.

Practical Wireless Telegraphy

It is proper that a journal devoted to electrical interests should avail itself of fitting opportunities to advance those interests in every legitimate way. On the other hand, it is neither honourable nor in the long run conducive to those interests to convey even by implication erroneous impressions regarding the utility or value of electrical or kindred enterprises, the success and earning capacity of which have not yet been demonstrated; nor to wink at statements relative to such enterprises that may be calculated to mislead a credulous lay public into unwise investments.

Hence, from time to time, as occasion has arisen, we have called attention to apparently erroneous or misleading statements of this nature that have appeared in the daily newspaper press. In this action we have stood almost alone among technical journals. Indeed, we have noticed statements in the columns of the technical press that, however inadvertently made, were nearly as well calculated to convey an erroneous impression concerning alleged facts relating, for instance, to wireless telegraphy, as are some of the statements of the advertisers of wireless telegraph stock.

For example, it was recently stated, accurately enough, in an item on

wireless telegraphy, that one of the ocean steamships had received messages from Poldhu half-way across the Atlantic, and from Cape Cod across the remaining half of the voyage. No messages were sent from the vessel to the land stations. Yet in the face of this fact, it was seriously stated that the ability of a steamship to keep in touch with the world during an ocean voyage having been demonstrated, the dread which many feel regarding sea voyages should be removed. The point is that, inasmuch as the vessel was not able to communicate with the shore stations during several days of the voyage, it is evident that, so far as the whereabouts of, or the happenings to, that vessel during that time were concerned, the agents of the vessel and the friends of the passengers were as completely in the dark as though wireless telegraphy had not existed.

In the literature sent out broadcast by the stock brokers having in charge the sale of certain wireless telegraph securities, some amusing statements are made. Thus one stock broker avers that his reason for seeking the small investor is that he controls the most money. There are at least two other very good reasons why he does so, namely, because the small investor is more gullible than the large investor, and because the latter has facilities for obtaining information relative to the merits of an invention or a business that are not open to the former.

Even some professional men whose opinions, by the way, on the merits of wireless telegraphy are worth in reality no more than those of any other layman, appear to be willing to lend their names to peculiar statements apparently designed to promote the sale of wireless stock. Thus in a testimonial given by a well-known professor of chemistry, and quoted in the same stock broker's literature, the following owl-like statement occurs:—

"The chances of a good revenue, both from the increased value of the stock and the use of the invention, are very promising. I firmly believe in all that the inventor has accomplished."

Almost any one might firmly believe in all that another had accomplished. But is not the statement seemingly intended to convey the idea that the professor firmly believes the inventor will accomplish all that he promises? Otherwise why is the statement made at all?

We yield to no one in our admiration of the results achieved by the practical workers in the field of wireless telegraphy. We have not ceased to marvel at those results, and we freely admit the great utility of this art in the work for which it is obviously pre-eminently adapted, namely, the transmission of intelligence from ship to ship at sea, and between ships and the shore. But one may admire the excellence of an art and yet not be blind to its limitations as a revenue earner.

In the literature to which reference has been made, great stress is laid on an alleged increase in the value of certain British wireless telegraph stocks, the implication being that this stock is a large dividend earner. In the May number of this journal we gave official figures showing that the total earnings of the company in question for the year 1904 were only $63,401.05, the capitalization of the company being $1,150,000.

Quite recently a statement in a British parliamentary report gave the total number of wireless telegraph messages sent to and from vessels at sea, under the recent arrangement with the British government, namely, 1766, for the three months ending March 31, 1905, an average of about 7064 messages per annum or twenty messages per day.

Assuming an average charge of $2 per message, this would provide a total income from this source of, say, $14,000 per annum, from which must be deducted operating expenses. As this utilization of wireless telegraphy has been advertised as one of the main sources of income, it is open to any one to draw conclusions as to the likelihood of any one company earning excessive dividends on capitalizations of one million dollars and over. With a capitalization fairly commensurate with the actual value of the wireless stations and equipments, and provided that these stations be not duplicated and triplicated by competing companies, a fair return on the investment might, of course, reasonably be expected. But it is known that these favourable conditions do not exist in the case of the companies that appear to be making the more strenuous efforts to dispose of their stock.

One of the latest advertisements in the daily newspaper columns relative to wireless telegraph stock announces that by means of a new magnetic detector and transmitter over one hundred words per minute can now be flashed, which, the advertisement adds, is three or four times the speed of the ordinary telegraph or cable, while the cost per word is less than half the cable rate.

This statement is, doubtless, founded on the report that Marconi expects to obtain a speed of one hundred words per minute with his magnetic detector, which expectation may some day be realized. In the present state of the art, however, twenty-five to thirty words per minute over comparatively short distances, say two hundred to three hundred miles, is the utmost speed attainable by wireless telegraphy. Furthermore, a speed of one hundred words per minute by the ordinary wireless spark transmitter is not yet practicable; and if it were, it would be impossible to receive one hundred words per minute, unless the variations of current set up by the detector were sufficiently powerful, at that rate of speed, to operate a Morse relay, to permit the reception of signals automatically. It is safe to say that such a detector has not yet been devised.

The maximum speed at which telegraph operators can receive signals by sound is not more than forty to fifty-five words per minute. An advertisement, therefore, which, like the one in question, is capable of conveying the impression that a speed of one hundred words is now being flashed by wireless telegraphy over long distances, is obviously misleading.

President Mellen, of the New York, New Haven & Hartford Railroad, has announced that the company plans to substitute the overhead trolley for the third-rail system on its line connecting Hartford, New Britain and Bristol, Conn., over which there has been a great deal of contention, owing to claims that the third-rail was a menace to life. The company had previously announced that it would return to a steam passenger service, which was strongly deprecated by the cities and towns affected. It is also proposed to equip the Highland division, between Hartford and Rockville, with the overhead trolley system for suburban service.

Bad joints, according to Walter M. Petty, in a recent paper before the International Association of Municipal Electricians, may be considered as the unpardonable sin among electrical men, especially those who have circuits carrying small volume currents. Even with care, however, they will sometimes develop, as there are so many causes that may produce them. Every binding screw, every fuse or cut-out, every connection of whatever nature may be considered as a source of bad joints trouble and treated accordingly. Needless to say, every line joint should be soldered or sleeved.

Artificial Illumination—IV

By Dr. EDWIN JAMES HOUSTON

Continued from the August number

SOME TYPES OF THE GENERAL ELECTRIC COMPANY'S APPARATUS FOR DIRECT AND INDIRECT ILLUMINATION

HAVING briefly pointed out a few of the differences between direct and indirect illumination, it may be of interest to describe some of the actual apparatus on the market in the United States. Lack of space will necessitate the passing by of many of the better known types employed for artificial illumination, such, for example, as the bare incandescent and arc lamps, as well as many well-known methods that are employed for partly covering arc or incandescent lamps with semi-transparent or translucent globes or shades. In this article will be described some of the more important apparatus manufactured by the General Electric Company, of Schenectady, N. Y.

FIGS. 1 AND 2.—MERIDIAN LAMPS MANUFACTURED BY THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y. FIG. 1 SHOWS THE EARLIER TYPE IN WHICH A METAL COLLAR REFLECTED THE LIGHT DOWNWARD, AND FIG. 2 SHOWS THE PRESENT TYPE IN WHICH A GLASS SHADE REPLACES THE METAL COLLAR

The meridian lamp employed by this company in connection with incandescent electric lighting, constitutes a source of illumination intermediate in its light-giving power between the incandescent and the arc lamp, being intended for the illumination of spaces for which the arc lamp is too large, and the incandescent lamp too small. In the construction of the meridian lamp, an effort has been made to combine in a single apparatus the high efficiency of the arc lamp with the simplicity of operation of the incandescent lamp.

Fig. 1 illustrates the No. 2 meridian lamp. In this, the incandescing filament is placed within a glass globe, the greater portion of the surface of which is frosted by sand-blasting. The upper portion of the globe, which is covered by the ornamental metal collar shown, is left unfrosted.

The under surface of the metallic collar is highly polished so as to act as a reflector. Since the portion of

the globe with which the collar comes in contact is left clear or unfrosted, the light which passes through this portion of the globe is reflected downward and passes out at the frosted, uncovered surface, along with the direct light from the lamp filament. In this manner the entire frosted surface of the globe glows with a uniformly brilliant white light.

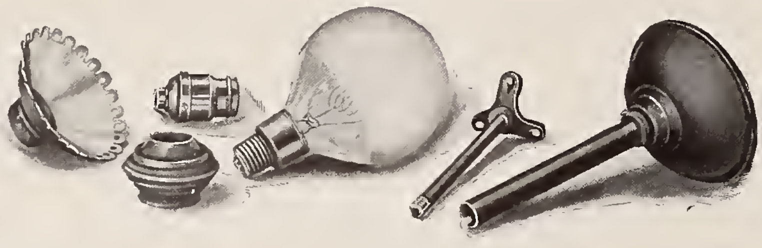


FIG. 3.—THE PARTS OF THE MERIDIAN LAMP SHOWN IN FIG. 1

Since, by the use of the reflector, all the light which would otherwise have passed upward through the unfrosted part of the globe is added to the light that passes directly through the frosted part, it is evident that the space below a plane passing through the lower part of the reflector will receive an illumination the intensity of which is higher than would otherwise have been produced in this space. In the No. 2 lamp, the intensity of illumination in this area is equal to that which would have been produced by the use of a 50-candle-power lamp. Since the filament employed in this lamp consumes about 120 watts, the efficiency is equivalent to about 2 watts per candle of useful light. The circular area lighted by the meridian lamp is equal in diameter to the height of the lamp above such area. From this area of uniform illumination, the intensity of the light gradually falls to a little more than one-half the intensity in a horizontal hemisphere.

The general appearance of the different parts of a meridian lamp can be easily seen from an inspection of Fig. 3. The incandescent lamp filament is shown in the enclosing globe. The clear upper portion of the globe that is covered by the reflecting collar when the parts of the lamp are assembled may be readily distinguished from the remaining frosted part. At the extreme left is the ornamental metallic collar or reflector, and at the extreme right is shown an extension tube for readily varying the height of the globe above a table, desk, and the like. When the collar is placed on the globe, its inner reflecting surface comes over the clear part of the latter, so that the light which would otherwise be lost by being thrown upwards, is reflected downwards from the metallic surface, and issues from the lower part of the frosted globe, mingling with the light that is thrown directly downwards from the filament, as already explained. This lamp is generally hung from eight to twelve feet above the floor of the room to be illumined, according to the general character of the surrounding walls and ceiling as regards diffusive power.

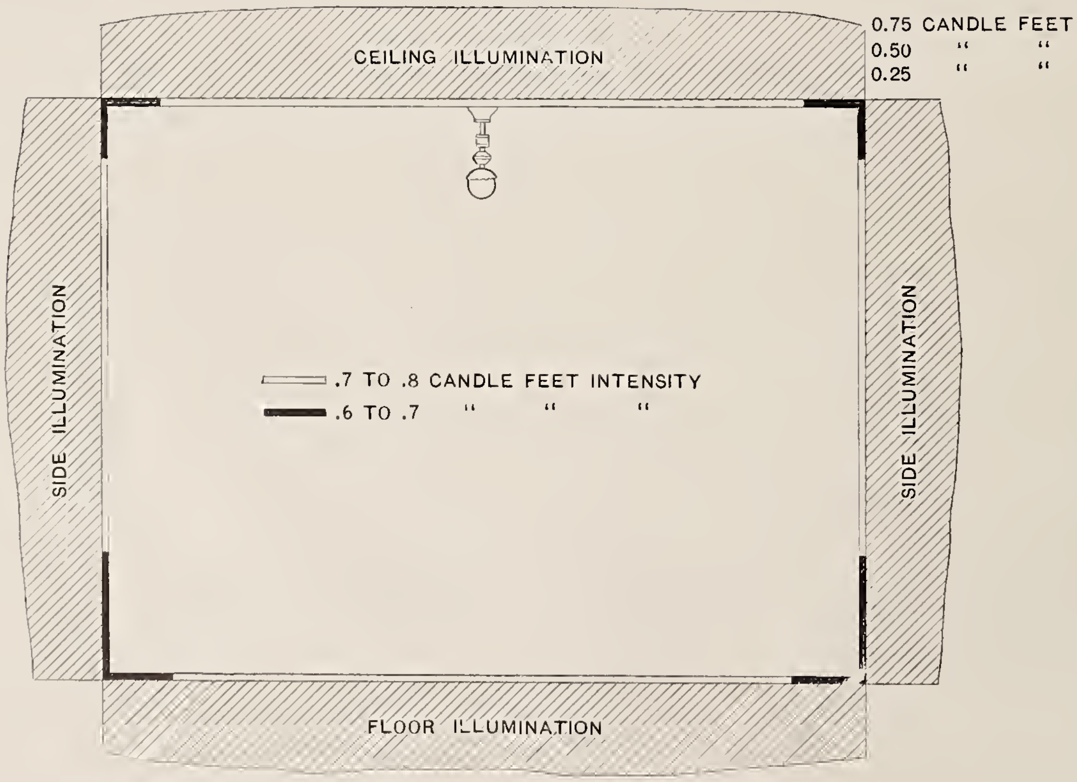


FIG. 4.—DIAGRAM SHOWING THE ILLUMINATION OF THE FLOOR, WALLS AND CEILING OF A ROOM 13 FEET SQUARE AND 10 FEET HIGH. ONE NO. 2 MERIDIAN LAMP IS PLACED IN THE CENTER, 1½ FEET BELOW THE CEILING

The meridian lamp is especially fitted for suspension from the ceilings of the rooms to be illumined, but is not designed for attachment to the wall brackets or side fixtures. It is manufactured in two different sizes and for two different efficiencies—No. 1 and No. 2, the former having one-half the candle-power and watt consumption of the latter. For general service the use of 60 and 120-watt lamps is recommended for ensuring a good useful life of about 500 hours. The use of 52½ and 105-watt lamps gives a much higher illumination with, of course, a decreased life.

FIG. 5.—THE PARTS OF THE MERIDIAN LAMP SHOWN IN FIG. 2

Fig. 4 gives some idea of the uniformity of the illumination obtained by the use of the meridian lamp. A room 13 feet square, with a ceiling 10 feet high, is lighted by means of a single No. 2 meridian lamp, suspended 1½ feet below the ceiling.

Since the intensity of illumination is inversely proportinonal to the square of the distance from the source, a No. 2 meridian lamp producing 50 candle-power will give on a surface of 7 feet below it about 1 foot-candle—a foot-candle being equal to the illumination produced by a standard candle at a distance of 1 foot, or by a 16-candle-power incandescent lamp at a distance of 4 feet.

$$\frac{50}{7^2} = \frac{50}{49} = 1 \text{ foot-candle.}$$

The same lamp at a distance of 10 feet from the floor will give an illumination of ½ a foot-candle, thus:—

$$\frac{50}{10^2} = \frac{50}{100} = \tfrac{1}{2} \text{ foot-candle.}$$

The shaded portions of the sides of the illustration represent the intensity of illumination of the ceiling, the walls and the floor space respectively. It will be noticed that the intensity of illumination is fairly uniform throughout the entire room on the floor, walls, and ceiling, which receive an illumination between 0.7

and 0.8 foot-candle. At the corners of the room, however, the intensity falls off to between 0.6 and 0.7 foot-candle.

Fig. 6 represents in a similar manner the illumination produced on the surface of a table 10½ feet long by two meridian lamps suspended at a height of 5½ feet above the table, and placed at a distance of 8½ feet from each other.

It has been found in practice that a difficulty exists in the operation of the form of meridian lamps above described, owing to the marked increase in temperature of the upper part of the lamp where it comes in contact with the metallic shade or reflector. In order to avoid this increase of temperature, and thus ensure an increased length of life of the lamp, a modification of the meridian lamp has been employed by replacing the reflector by a glass reflector or shade known as the "prismo" glass shade. Fig. 2 illustrates the meridian lamp as thus modified. Here, as will be seen, the metallic collar reflector has been replaced by a glass shade which operates in the same general manner as the holophane globes or reflectors described in the preceding article. This type of lamp has now almost

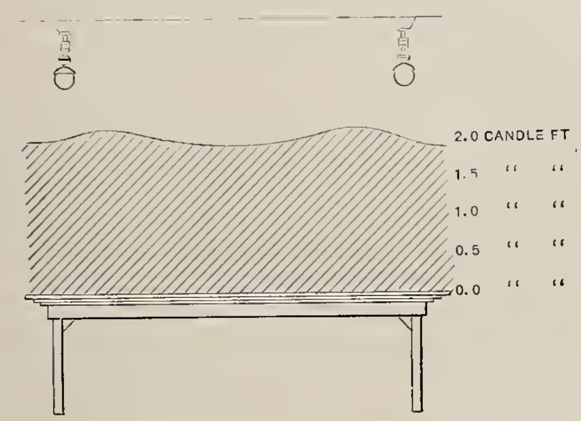


FIG. 6.—DIAGRAM SHOWING THE ILLUMINATION OF A TABLE 10½ FEET LONG. TWO NO. 2 MERIDIAN LAMPS ARE PLACED 5½ FEET ABOVE THE TABLE AND 8½ FEET APART

entirely superseded that shown in Fig. 1.

Fig. 5 shows the detailed portions of this lamp. Here, as in the former lamp, the globe is frosted by sand-blasting, except the upper portion, which is left transparent. The transparent glass is supported, as shown in Fig. 2, over the clear portion of the lamp, so that the light which would otherwise be lost by passing upwards, passes through the transparent portion of the globe and, falling on the reflecting glass shade, is either deflected downwards by the principal of total internal reflection, or a part of it passes outwards, thus giving to the reflecting shade a uniform illumination, and at the same time preventing such light from having a degree of intensity unpleasing to the eye.

Fig. 2 shows the glass shade provided with a metallic holder furnished with a number of apertures, thus permitting of the dispersion of a large part of the heat of the lamp. This construction of the meridian lamp, like that previously described, permits the ready replacement of a new lamp by the simple unscrewing of the globe. The lamp is either provided with a key socket, as shown in Fig. 2, or with a keyless socket.

Another form of apparatus of the General Electric Company for the employment of incandescent electric lamps as sources of illumination is what is known as the meridian diffuser. This consists, as shown in Figs. 7 and 8, of groups of meridian lamps placed below a deflector or diffuser of steel about 6 inches in diameter, formed of a high grade of white Austrian air-dried enamel. While any arrangement of incandescent electric lamps can be employed in connection with such a diffuser, yet the best results have been obtained in practice by employing one 25 to 50-candle-power meridian lamp in the lower socket, and three, four, or five standard 8, 16 or 32-candle-power incandescent lamps in the other sockets. By the use of this diffuser, an area of comparatively uniform illumination can be obtained below the diffuser of a much greater intensity than would result from the use of the lamps alone.

FIG. 7.—A DEFLECTOR OR DIFFUSER IS SOMETIMES USED WITH MERIDIAN LAMPS AND ORDINARY INCANDESCENTS TO OBTAIN A MORE UNIFORM ILLUMINATION

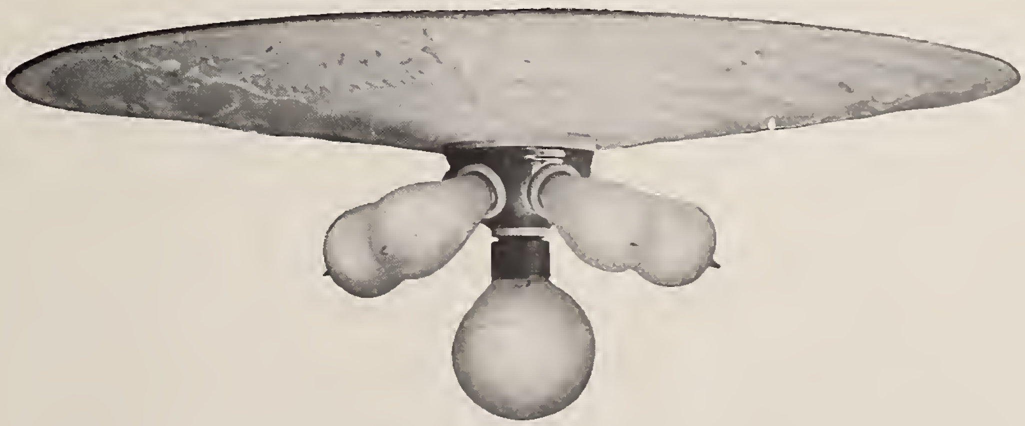


FIG. 8.—ANOTHER VIEW OF THE DIFFUSER SHOWN ABOVE

The high efficiency of the arc lamp, together with the near approach of its color value to ordinary sunlight or daylight, renders it an extremely suitable source for the illumination of interiors, provided some of the objections to the use of this light can be avoided.

As is well known, a bare arc light is not suited for interior lighting,

FIG. 9.—AN ENCLOSED ARC LAMP WITH A CONCENTRIC DIFFUSER

since it produces immediately below the lamp a dark zone surrounded by a ring of highly concentrated light. Beyond this ring the intensity of illumination rapidly decreases. A light of this character is entirely unfitted for the display of coloured goods, since the excess of light that enters the eye of the observer within this zone produces retinal fatigue that makes it impossible to obtain distinct retinal images. Besides this, the intense excitation of the retina by coloured objects results in the production of complementary colours that prevent the true colours being seen.

While it is true that, to a great extent, the difficulties above referred to can be avoided by covering the globes of arc lamps with translucent globes, yet another difficulty presents itself, due to the unsteadiness of the arc light, caused both by the wandering of the arc and the great variations in its intensity that take place at the moment the lamp is feeding.

A variety of apparatus is made by the General Electric Company for obtaining uniform illumination with an arc lamp. Among the most important are the concentric diffuser and the light-balancing selective-diffuser ceiling.

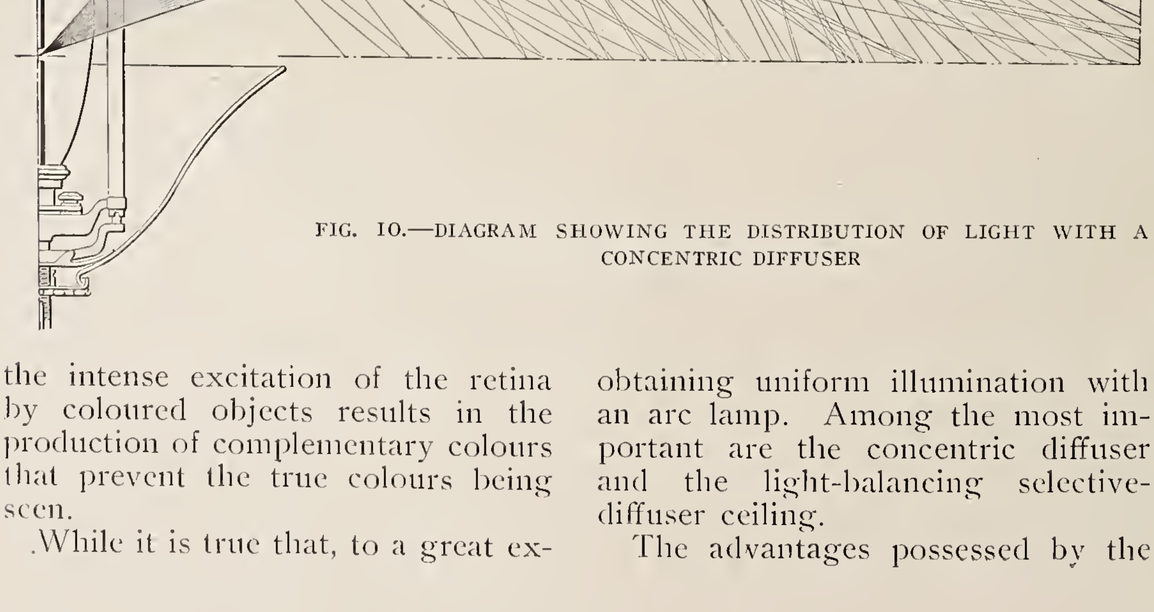


FIG. 10.—DIAGRAM SHOWING THE DISTRIBUTION OF LIGHT WITH A CONCENTRIC DIFFUSER

The advantages possessed by the enclosed-arc lamp over the open-arc lamp are so marked that the former is rapidly replacing the latter. In the concentric diffuser and the light-balancing selective-diffuser ceiling, enclosed-arc lamps are employed. Some of the advantages possessed by the enclosed-arc lamps are to be found in the quality of the illumination, the even distribution of the light, and the economy of maintenance.

Fig. 9 shows the general appearance of a concentric diffuser placed over an enclosed-arc lamp. As will be seen, the outer globe of the enclosed-arc lamp is replaced by a screening shade provided with an upward flare. This shade performs the double function of subduing the light immediately under the lamp, and of reflecting a portion of the light to the diffuser.

The diffuser consists of a metallic ring provided with a series of concentric flutings, placed, as shown, directly above the larger end of the shade that takes the place of the upwardly flaring glass screen or outer globe of the enclosed-arc lamp. The surface of the diffuser is covered with some suitable diffusing substance, such as aluminium paint, which possesses in a high degree the power of scattering or diffusing the light.

The light obtained by the use of the concentric diffuser possesses the well-known characteristic white colour of the carbon arc lamp, and

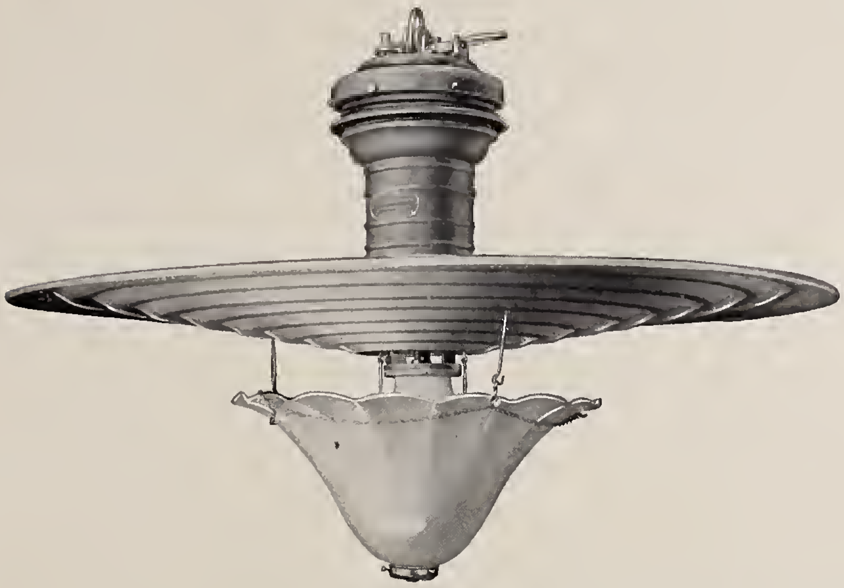
is therefore well adapted to the display of coloured goods, the matching of colours, and for any character of high-grade interior illumination.

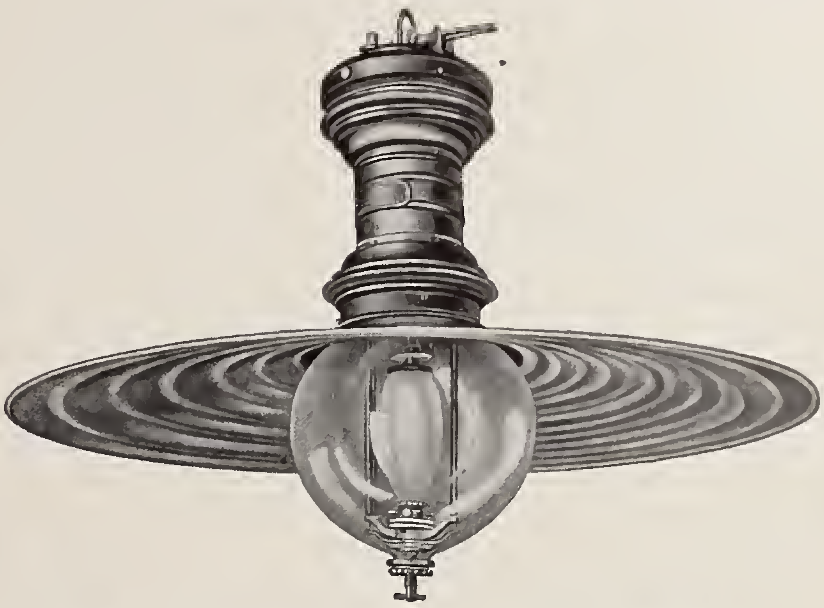
The use of the concentric light diffuser possesses the great advantage of making it a matter of indifference whether the ceiling of the room to be illumined is a good diffuser of light; or, in other words, it makes the illumination independent of the character and colour of the ceiling, since the diffuser prevents the loss of light by absorption by the ceiling.

Fig. 10 illustrates the general action of the concentric diffuser on the upward rays of light from the arc lamp. An upward pencil of rays that would otherwise, to a great extent, be lost by falling on the surface of a poorly diffusing ceiling, are received on the concentric flutings of the metallic diffuser and deflected generally downwards so as to be uniformly spread over a circular surface lying below the lamp. Thus, not only is an increased amount of light in such region ensured, but the uniformity in its illumination is also markedly increased.

The concentric light diffuser was originally designed for use with the double-globe lamp provided with the outer globe lowering device and a single-globe casing. In order to permit the use of the diffuser with lamps not of this general construction, adapters were devised for single-globe lamp. Fig. 11 illustrates a ring adapter for a single-globe lamp. The adapter is fastened to the diffuser in the manner shown and in no way interferes with its proper action.

In some cases, such as in cotton mills, where it is necessary to supply an outer globe in order to prevent fires being started by flying particles of cotton coming in contact with the hot enclosing globe, a modified form of diffuser known as the inverted concentric diffuser is employed. This form of diffuser is also suitable for use either with single-globe lamps or with double-globe lamps equipped with open base outer globes. It may also be advantageously employed in high, studded rooms where it can be used very satisfactorily without the outer globe. Fig. 12 illustrates a double-globe arc lamp provided with an inverted concentric diffuser.





FIGS. 11 AND 12.—FIG. 11 SHOWS A SINGLE-GLOBE ARC LAMP WITH A DIFFUSER AND A SHADE, AND FIG. 12 A DOUBLE-GLOBE ARC LAMP WITH AN INVERTED DIFFUSER

The light-balancing selective-diffuser ceiling is especially useful for obtaining a practically uniform distribution of the light of an enclosed-arc lamp irrespective of the position of the arc. By means of this device the difficulties arising from the traveling of the arc are practically avoided, since the device is of such a nature that the diffuser will throw a

FIG. 13.—A LIGHT-BALANCING SELECTIVE DIFFUSER CEILING USED WITH AN ARC LAMP

sufficient amount of light in a direction opposite to that occupied by the shifting arc to ensure a comparatively uniform illumination over the entire space to be illumined.

The light-balancing, selective-diffuser ceiling is capable, moreover, of not only greatly softening the light in the immediate vicinity of the lamp, but also of increasing the intensity of points midway between the lamp, practically doing away with deep shadows.

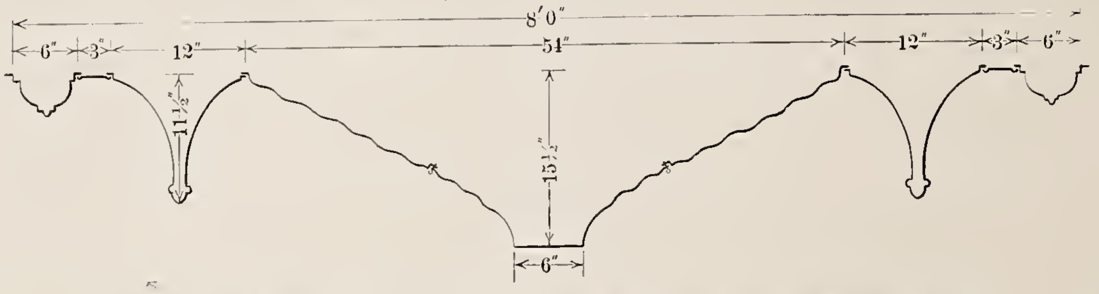


FIG. 14.—SECTION OF THE LIGHT-BALANCING SELECTIVE DIFFUSER CEILING

In this system of illumination the lamps are hung as high as the ceilings will permit, thus enabling them to be placed out of the direct line of vision. Fig. 13 illustrates the light-balancing selective-diffuser ceiling with corner plate, beam molding and zinc drop block, and Fig. 14 is a vertical cross-section of it.

One of the most useful parts of this ceiling is the light-balancing cove. This part is employed for the purpose of maintaining a fairly uniform illumination, no matter how much the arc may travel, that is, no matter on what side of the carbon electrode it may happen to be. This device is of especial importance where the ceilings are high, or in small rooms where there is only one or two lamps. In large rooms where a number of lamps are employed, the balancing cove is not so important.

Fig. 15 illustrates the general manner in which the light-balancing cove operates. Suppose, for example, that the arc is on the right-hand side of the carbon, as shown. With an ordinary arc lamp unprovided with a light-balancing selective-diffuser ceiling, the illumination would be excessive on the right-hand side of the lamp, and deficient on the left-hand side. With the light-balancing selective-diffuser ceiling, however, the light-balancing cove is able to throw such an additional amount of light by diffusion to the other side of the carbon as to produce a fairly uniform illumination on all sides of the lamp.

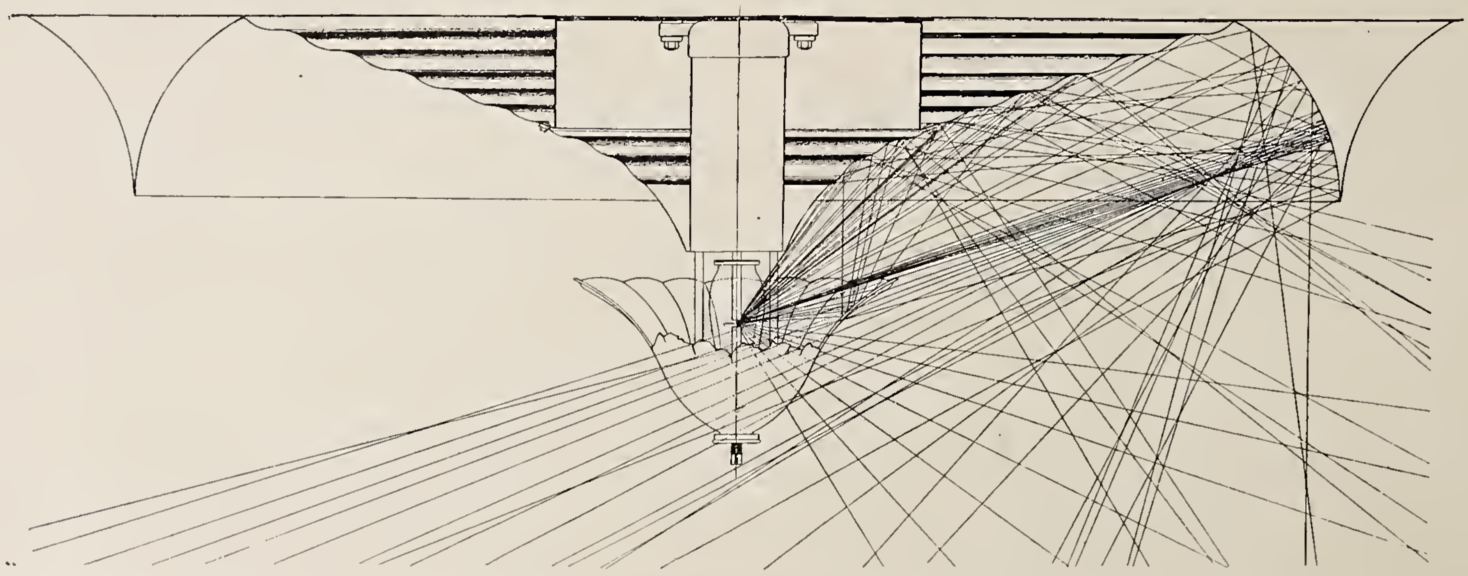


FIG. 15.—THE LIGHT-BALANCING SELECTIVE DIFFUSER CEILING PRODUCES A UNIFORM ILLUMINATION ON ALL SIDES OF THE LAMP, AS HERE SHOWN

Bridgetown, situated a few miles from Dulverton, Somerset, according to "The Electrical Engineer," of London, claims to be the smallest village in England supplied with the electric light. A local wheelwright laid down a plant to supply his own premises. His neighbours expressed a desire for similar illumination, so the wheelwright added to his plant, and is now supplying electricity to others in the village. The population is less than 100.

The Ontario Power Company at Niagara Falls expects to begin continuous and commercial operation about the first of October.

Rubber Growing in Ceylon

CEYLON has made wonderful strides in rubber growing during the last few years. According to information supplied by the Institute of Tropical Research, recently founded in connection with Liverpool University to encourage the development of the colonies on scientific lines, Ceylon has, during the past season, shipped 100,000 pounds of rubber, all produced from the island plantations. This rubber is exported in the form of small, flat, transparent cakes, now known to merchants as Ceylon "biscuits," which, being of chemically pure rubber, the rubber milk having been coagulated in moulds specially made for the purpose, command a high price.

The growing of rubber has been going on for some time in Ceylon, but merely as a botanical experiment, and in no sense on a large or commercial scale until within the last three or four years, when for the first time the seeds of the Para Hevea began to reach the colony in considerable quantities. Since that date, no fewer than 60,000 acres have been planted in Ceylon, and an equal area in the Straits Settlements, at the rate of 250 trees to the acre. The whole of the planting is done on most systematic and scientific lines, with the result that the trees reach sufficient maturity for them to be producing at as early as three years in exceptional cases, and in almost all cases in six years, as against eight or ten years in other parts of the world.

This year no less a quantity than 4,000,000 seeds were sold and the whole of these have now been planted, while probably this represents only about half of the total plantation that has gone forward during the

RUBBER TREES IN CEYLON

past twelve months in Ceylon alone. It is reckoned that during the present year at least another 100,000 acres will be brought under rubber cultivation in Ceylon, and probably a similar area in the Straits Settlements, which will give a total cultivated area in the two colonies of 320,000 acres, representing no fewer than 80,000,000 rubber trees actually under cultivation. This far surpasses anything hitherto attempted in any other part of the world, for it must be remembered that even in the Congo the much-vaunted 60,000,000 rubber trees include not only those under cultivation, but all the rubber vines and plants known to exist in a wild state. Moreover, the figure is at best merely an estimate.

In three years, at the present rate, and allowing for no further extension of the rubber cultivated area, Ceylon and the Straits Settlements will be in a position to supply with the finest rubber at present known in the world the entire demand for rubber of any kind. In making these calculations as to the future, it should be borne in mind that the areas referred to include districts in which trees have been planted on sites quite unsuitable for the cultivation of rubber.

It is generally admitted that rubber cannot be successfully grown at a greater altitude than 1500 feet above sea level, yet so keen is the "boom" at the present moment in the island of Ceylon that planters and estate owners are setting rubber seeds all over their land, quite irrespective of its suitability. Some plantations reckoned in the figures given above are at no less altitude than nearly 5000 feet, and will probably never yield a satisfactory rubber in remunerative quantities. The profits of rubber-planting are enormous, and from $200 to $300 an acre is by no means an extravagant figure to reckon as the average in well-chosen localities, while $1000 an acre for yearling trees has already been paid. In addition to the actual rubber produce there is, as has been indicated, a large profit to be made from the sale of the seed at the present time, although this is only a temporary condition.

To the many recent reports of the discovery of new sources of rubber may be added the one that a tree has been found in Madagascar containing much caoutchouc juice. This coagulates on boiling, producing 89 per cent. caoutchouc of good quality. The tree is found in groves in the northwestern part of the island.

The capital invested in electric lines in the United States, including street railways, has been placed at $2,127,634,000.

Old-Time Telegraphers' Meeting

ANNUAL REUNION OF OLD-TIME TELEGRAPHERS AND HISTORICAL ASSOCIATION AND THE U. S. MILITARY TELEGRAPH CORPS

THESE organizations consist respectively of those who were telegraphers at least twenty years ago, but many of the members were in the telegraph service thirty-five, and some of them even fifty, years ago. To-day many of these members are prominent as bankers, statesmen, lawyers, physicians and authors. The Historical Association, which is now merged with the Old Time Association, has for its object the preservation of apparatus and documents pertaining to the early days of the telegraph. The United States Military Telegraph Corps is composed exclusively of the telegraph operators who were in the United States telegraph service during the Civil War. Naturally, the majority of those left in the ranks are now in the yellow leaf and sere. Among the more prominent of those remaining and present at this reunion were Messrs. D. H. Bates, ex-president of the Baltimore & Ohio Telegraph Company; E. Rosewater, editor of "The Omaha Bee," and Col. W. B. Wilson, of Philadelphia.

The three organizations meet annually in different cities of the United States and Canada. Last year, for instance, the reunion was held at Atlanta, Ga.; in 1903 it was held at Milwaukee; this year, being the twenty-fifth anniversary of the association, New York City was selected as the appropriate meeting place. The meetings are in the strictest sense reunions, no business whatever being transacted except that which relates to the election of officers and members, the selection of the next meeting place and any other perfunctory work that may come before the meetings.

At these meetings many who for years have known each other "over the wire" now meet face to face for the first time; and others who were boys together, thirty or forty years ago, now meet for the first time in all these years. As there is a comradery among telegraphers that is rarely surpassed, if indeed it is equalled, in any other profession, the pleasurable outcome of these reunions may be readily understood. Apart from the question of friendship that surrounds these meetings there is also no doubt a certain advantage from a business standpoint in having the representatives of the various companies come into personal touch with one another, a point which, it may be assumed, is taken into account by the officials of these companies who have long fostered these reunions, and without whose kindly co-operation they obviously could not continue.

The headquarters of the present reunion were located in the Waldorf-Astoria Hotel, the second floor of which was almost entirely given over to the members of the associations and their wives, to the number of a thousand or more.

The only business meeting of the joint associations was called to order by President J. C. Barclay at 11 o'clock on Tuesday, August 29, in the grand banquet hall. After a brief address of welcome Mr. Barclay introduced Charles V. Fornes, the acting Mayor of New York City, who, in well-chosen words, offered the freedom of the city to the visitors. Charles Selden, of Baltimore, Md., in his usual happy manner, replied on behalf of the associations.

After the reading of the report of the secretary-treasurer, John Brant, which report showed a balance of $1140, the meeting proceeded to the election of officers for the ensuing year, Washington, D. C., having been selected for the next annual reunion. W. H. Young, of Washington, D. C., was elected president. Messrs. C. W. Riddle and Charles P. Adams, Washington, D. C., and J. B. Yeakle, Baltimore, Md., were elected vice-presidents. John Brant, New York, was re-elected secretary-treasurer.

The meeting then adjourned and the remainder of the day was given over to sight-seeing. In the evening many of the members attended a theatre party at the Broadway Theatre, at which the "Pearl and the Pumpkin" was running. As usual on such occasions the actors introduced a number of puns and jokes bearing on the character of the audience.

A steamboat sail up the Hudson and around East River, and thence to Coney Island, was planned for the following day. This was largely attended and greatly enjoyed by the visitors.

The piece de resistance of the reunion was reserved for Thursday evening, namely, the banquet at the Waldorf-Astoria. Covers were laid for over seven hundred people, which taxed the utmost capacity of the banquet hall and ante-rooms. Those who could not be accommodated at the tables were assigned to chairs in the gallery overlooking the banquet hall, where refreshments were passed to them during the evening.

Among those at the table of honour were Messrs. J. C. Barclay, Wm. H. Baker, T. A. Edison, R. C. Clowry, Clarence H. Mackay and Wm. B. Wilson.

President Barclay in a neat speech assigned the office of toastmaster to Melville E. Stone, the general manager of the Associated Press, who officiated in that capacity in his usual gracious manner.

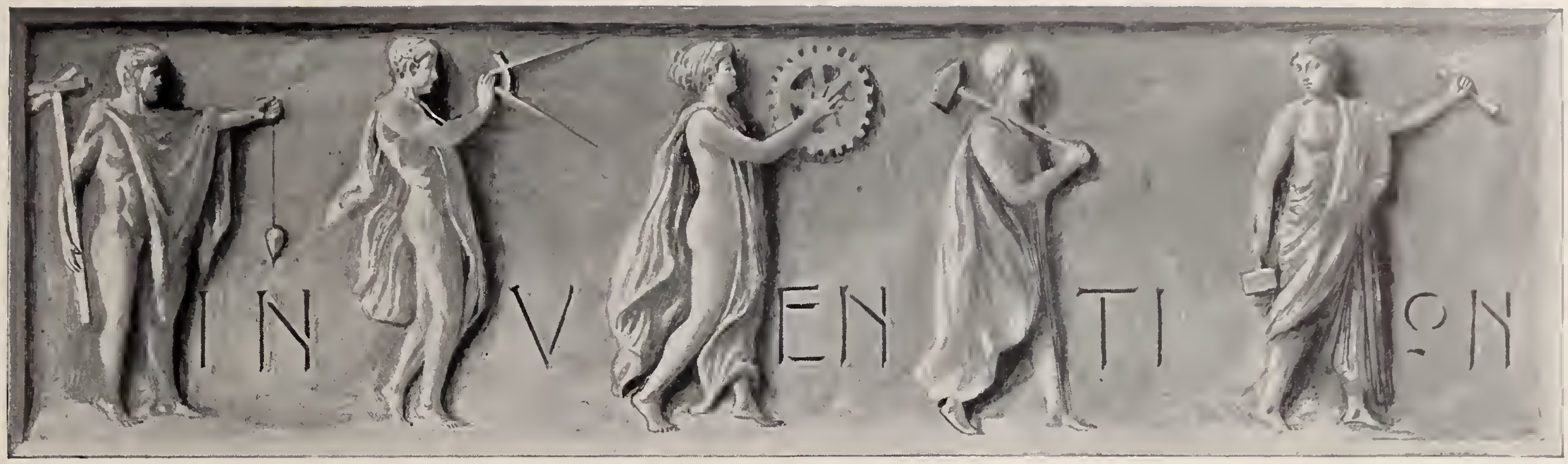
The first toast of the evening was drank to President Roosevelt amid much enthusiasm. The first speaker of the evening was Col. R. C. Clowry, president of the Western Union Telegraph Company, whose subject was "The Old-Timers." Col. Clowry's address was well received, and at its conclusion he gave well-merited praise to President Barclay for his arduous services in preparing and carrying out the arrangements for the reunion.

The other speakers of the evening were Thomas F. Clark, whose topic was "The Telegrapher as a Factor in Intellectual Progress"; U. N. Bethell, who pleasantly discoursed upon "The Telephone" and cognate subjects; T. W. Goulding, whose subject was "Our Friends Across the Sea"; Henry D. Estabrooks, who courteously discussed "The Ladies"; and Col. W. B. Wilson, to whom was assigned the toast of "The Military Telegraphers."

During the progress of the speeches the audience did not hesitate to interject appropriate suggestions or enquiries suggested by the remarks of the speakers. When one speaker had stated that over a century ago, when the only inland method of transportation from New York to Boston was by stage coach, the ratio of accidents was greater than it is by railroad, an auditor enquired, "How about automobiles?" When another speaker failed to be heard in all parts of the room, there were subdued requests from the old telegraphers to "stick in a repeater," the well-known telegraphic method of improving transmission when the signals are weak.

Souvenirs in the shape of miniature telegraph keys, suitable for watch-charms, and made by J. H. Bunnell & Co., New York, were presented to the guests. The banquet was not over until long past midnight.

Many of the guests remained in the city over Friday and passed the day in sight-seeing under the guidance of various members of the reception committee.

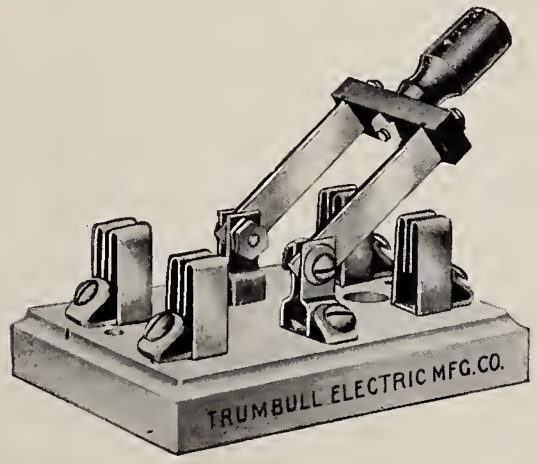


Electrical and Mechanical Progress

A New Knife Switch

A NEW knife switch manufactured by the Trumbull Manufacturing Company, of Plainville, Conn., is shown in the annexed illustration.

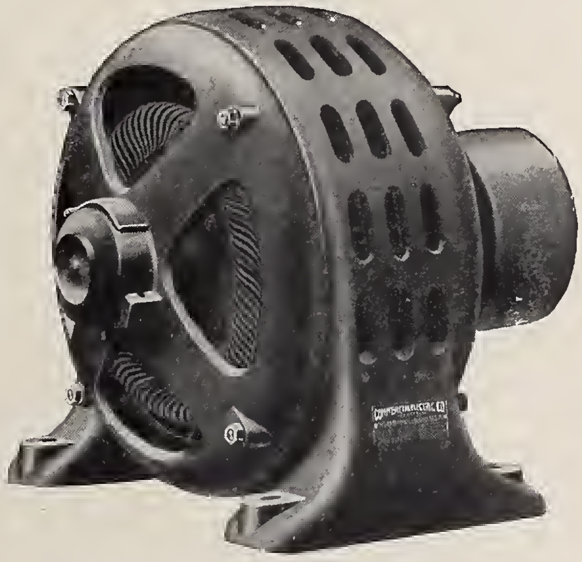
As will be seen, the front clips of the switch are self-adjusting, insuring perfect contact, even though the porcelain should be a trifle uneven. The binding contacts project from the base, making it easy to fasten the wires, which enter from the back



A NEW KNIFE SWITCH MADE BY THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, PLAINVILLE, CONN.

through holes left for this purpose. The handle is greatly strengthened by having the fastening screw extend nearly the entire length, and it is impossible for it to be broken by any strain received in ordinary use.

New Induction Motors



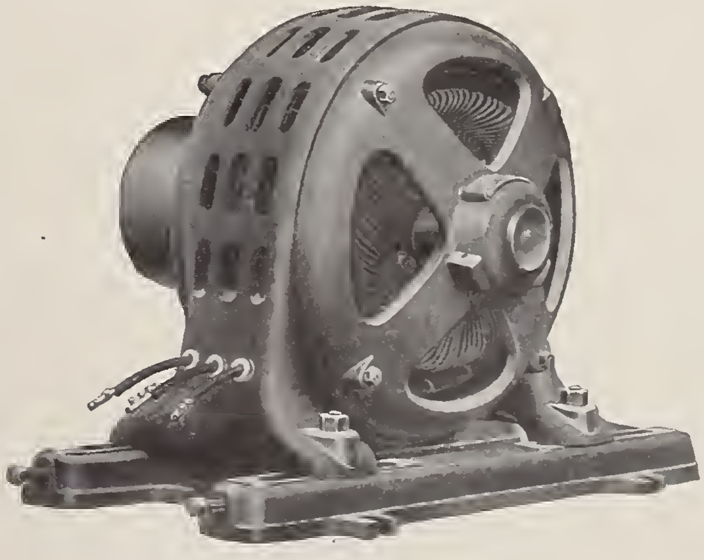
A NEW INDUCTION MOTOR BUILT BY THE COMMERCIAL ELECTRIC COMPANY, OF INDIANAPOLIS, IND.

NEW induction motors recently placed on the market by the Commercial Electric Company, of Indianapolis, Ind., are shown in the annexed illustrations. In order to produce a high power factor in these machines, it is essential that they have a limited clearance between the external diameter of the rotor and the internal diameter of the stator. The stator frame and head are therefore designed to secure and maintain this division of clearance, and to make it impossible in assembling the machine to give the rotor an unequal gap on opposite sides. To reduce the wear of the rotor shaft to a minimum, very large bearing surfaces are provided.

The advantages claimed for these motors are:—High power factor, large nominal break-down factor, high efficiency at both heavy and light loads, low working temperatures, small idle currents and high starting torque.

The bearings are self-oiling and self-aligning and are arranged so that the machines can be conveniently inverted, when location renders it desirable. The bearings are so designed that if the operator should flood them with oil no damage to the machine could possibly occur. The bearings will be made dustproof where desired. The linings of the bearings are duplicate and interchangeable, so that their replacement is a simple and inexpensive matter.

The shafts are of crucible steel of large diameter, and the distance between bearings is reduced to a minimum so that the shafts are very rigid and are not easily sprung. They are accurately ground to gauge and the bearings are carefully polished. The rotors are mounted on the shaft with hydraulic pressure. Ventilating apertures are provided across the faces of the stator and rotor cores so that a free circulation of air is secured, thereby insuring cool operation.



ANOTHER VIEW OF THE COMMERCIAL ELECTRIC COMPANY'S INDUCTION MOTOR, SHOWING SKIDS ON THE FEET

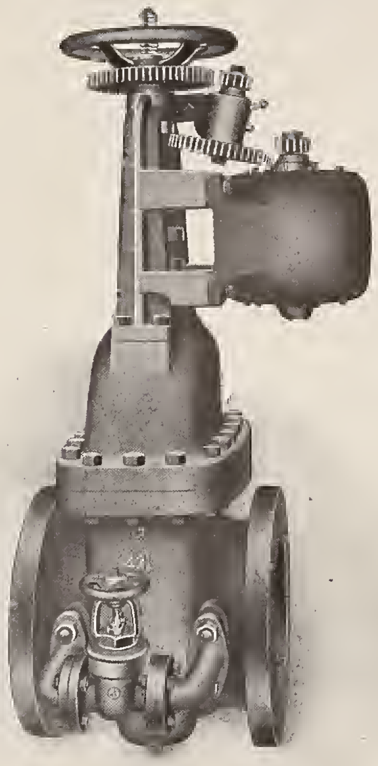


FIG. I.—A 12-INCH VALVE BUILT BY THE CHAPMAN VALVE MANUFACTURING COMPANY, BOSTON, MASS., OPERATED BY A MOTOR BUILT BY THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Especial attention is given to the starting devices used in connection with these machines, so that, it is claimed, the starting current is reduced to practically that used in the direct-current motors of corresponding capacities. Unless otherwise specified, paper pulleys will be used on these machines, as is the practice in the company's direct-current apparatus.

The motors illustrated are built in all standard sizes, voltages and frequencies for two and three-phase work from 5 H. P. to 200 H. P. For less power, single-phase, self-starting induction motors are made in capacities of from 1 to 5 H. P.

The Application of Electric Motors to Gate Valves

In designing electrically-operated valves, the conditions governing the application of the electric motor to the valve have been found to differ entirely from their application to all other machinery, inasmuch as the travel is, of course, limited to the size of the valve opening.

In the annexed illustrations are shown valves made by the Chapman Valve Manufacturing Company, of Boston, Mass., and operated by motors built by the General Electric Company, of Schenectady, N. Y. This development practically solves the problem of the rapid handling of large gate-valves under ordinary conditions, and especially in cases of emergency.

The valves are of the double-faced, solid-wedge plug type, and have a straight-way passage the full diameter of the connecting pipe. This is the simplest and strongest design for the purpose. It requires the smallest number of working parts and offers the least resistance to the passage of the fluid. Valves of this class are especially suited for water, steam and oil lines, and for low-pressure work, such as exhaust and condenser piping, pump suctions and discharge sewage, irrigation systems, blast furnaces, and the like. They

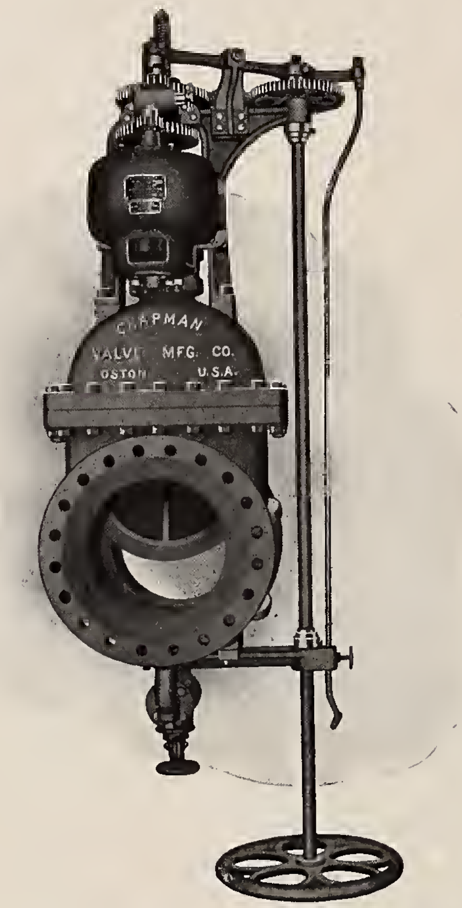


FIG. 3.—A SPECIAL 14-INCH CHAPMAN VALVE WITH A ¾-H. P. GENERAL ELECTRIC DIRECT-CURRENT MOTOR, ARRANGED FOR USE IN A VERTICAL PIPE LINE AS A THROTTLE VALVE FOR CURTIS STEAM TURBINE, WITH CLUTCH FOR DISCONNECTING MOTOR FOR HAND OPERATION

are also extensively used on the receiver piping of compound and triple-expansion engines, and are rapidly coming into use as throttle valves on steam turbine units.

The problem of motor operation of these valves was rather difficult, but was overcome by a direct-current motor especially designed for the purpose, a lost motion device in the connecting gear enabling it to attain a high speed in starting, as it is series wound, before the work of starting the valve plug was thrown on. On account of its peculiar winding, the motor exerts a very large torque at starting, and at the same time strikes a hammer blow

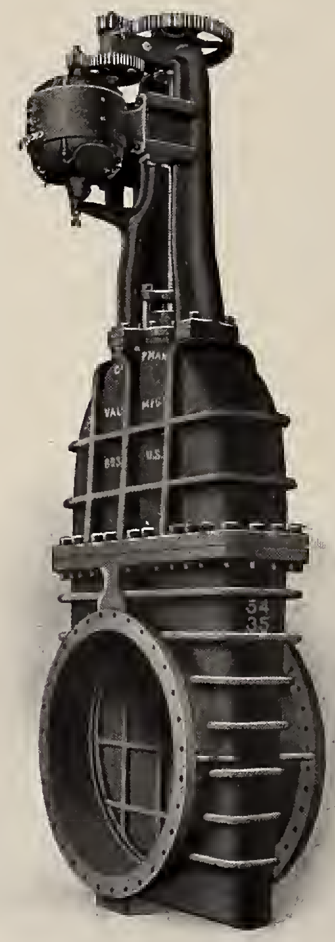


FIG. 2.—A 10-TON, 54-INCH CHAPMAN VALVE OPERATED BY A 5-H. P., DIRECT-CURRENT GENERAL ELECTRIC MOTOR

which is bound to unseat the valve, no matter how tightly closed.

Fig. 1 shows a 12-inch valve with 1-H. P., 2-phase, 60-cycle induction

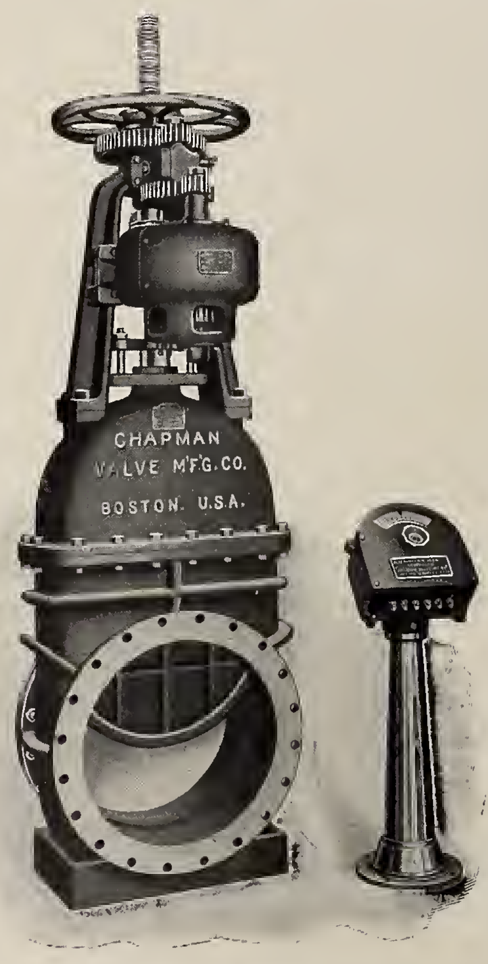


FIG. 4.—A 24-INCH CHAPMAN VALVE OPERATED BY A 2-H. P. GENERAL ELECTRIC DIRECT-CURRENT MOTOR, WITH REMOTE CONTROL AND INDICATOR

motor. The gearing is shown disconnected for operating the valve by hand.

Fig. 2, an example of the effective results obtained by electric motor operation of large valves, shows a 54-inch valve with a 5-H. P. motor. The valve weighs approximately 10

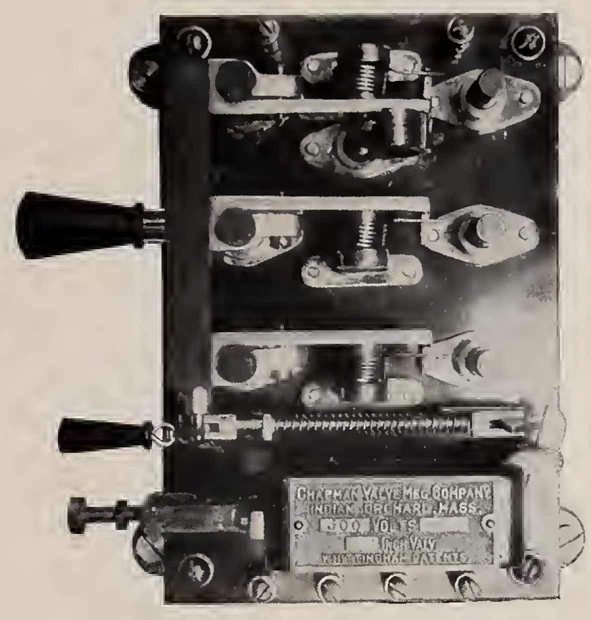


FIG. 5.—AUTOMATIC STARTING SWITCH FOR ELECTRICALLY CONTROLLED CHAPMAN VALVES OPERATED BY GENERAL ELECTRIC MOTORS

tons. In a test it required four men nearly thirty minutes to open it, while, motor operated, it required less than four minutes at a current consumption of only 2 amperes at 500 volts. This valve is installed as the main exhaust at one of the stations of the International Street Railway Company, of Buffalo, N. Y.

Fig. 3 shows a special 14-inch valve, with a $\frac{3}{4}$-H. P. motor arranged for use in vertical pipe lines as a throttle valve for Curtis steam turbines, with clutch mechanism for disconnecting the motor for hand operation.

These valves may be opened and closed at any reasonable distance from the point where they are located, it being only necessary to connect the valve with the operating stations by a two-wire circuit. The automatic switch shown in Fig. 4 is furnished with all standard equipments. In operating these valves, it requires considerably more current to start them from their seat than for the actual operation, and it is, therefore, necessary that some "fool-proof" device be used.

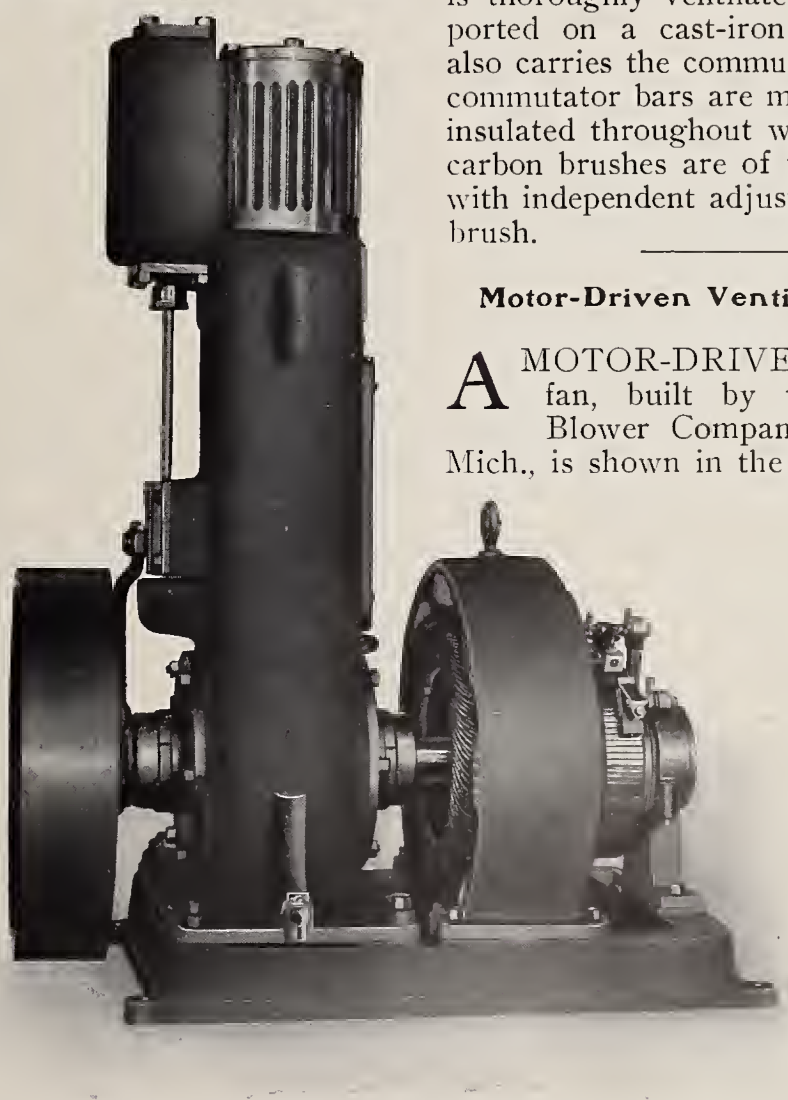
By reference to the illustration, it will be noticed that a secondary contact is used under the left-hand lever, cutting in or out the circuit-breaker according to the position of the switch blades. When a valve is to be started, the lever is depressed only until the contact is made, the circuit-breaker not being in circuit under these conditions, but should the operator desire to leave the switch in and go about other duties, locking it automatically cuts in the circuit-breaker, which affords protection to the motor during the remainder of the run, the idea of the device being that the operator has all the current available that the motor will pass, during the unseating, but is protected by a circuit-breaker as soon as the switch is locked in.

The motors are of a special series winding, having high starting torque with a very low speed, and are guaranteed to withstand the rush of current which will ensue should the motor be stalled or should the circuit-breaker fail to act for a period of from fifteen to thirty minutes, without injury to the windings.

A method of operating the valve through incremental steps of opening and closing with visual indication of the position of the valve plug or gate, at the point of operation, is being developed. A valve and controller-indicator of this type is shown in Fig. 5.

A New Direct-Connected Marine Set

A NEW direct-connected marine set placed on the market by the Fisher Electrical Works, of Detroit, Mich., is shown in the annexed illustration. While this set has been designed with special reference to marine work, it makes a very compact and reliable outfit for stationary purposes. The machines are furnished in four sizes of 8, 10, 15 and 25 KW.



A NEW DIRECT-CONNECTED MARINE SET BUILT BY THE FISHER ELECTRICAL WORKS, DETROIT, MICH.

The engine is of the enclosed, self-oiling type, and lubrication of every part of the engine is accomplished without the use of oil cups. The oil feed to the main journals and eccentric strap is visible and adjustable. The main journals are of babbitt metal, have taper adjustment, and cannot by ignorance or carelessness be thrown out of line with each other. The connecting rod is of the marine type, and is made of steel. The cross-head is of gun metal, and by means of large hand-hole plates on the side and rear of the engine frame all working parts are easy of access. The main shaft is of steel in one length without coupling; it carries on one end the armature, and on the opposite end the fly-wheel. The out-board bearing of the main shaft is self-oiling. The engine is equipped with Rites governor, and a balanced piston valve is used. The cylinder and steam chest are cast in one piece, the former being jacketed either with a polished cast plate or with Russia iron, as desired.

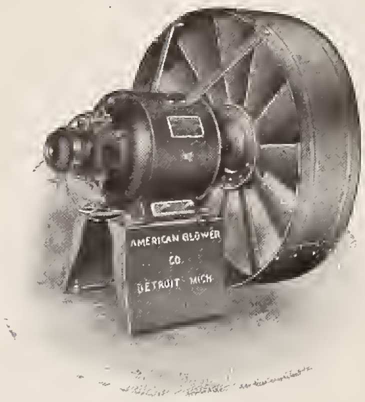
The dynamo is provided with eight poles, and the series and shunt coils are wound separately. The armature is thoroughly ventilated, and is supported on a cast-iron spider which also carries the commutator hub. The commutator bars are made of copper, insulated throughout with mica. The carbon brushes are of the radial type with independent adjustment for each brush.

Motor-Driven Ventilating Fans

A MOTOR-DRIVEN ventilating fan, built by the American Blower Company, of Detroit, Mich., is shown in the illustration on

this page. The fan is provided with 12 steel blades, each overlapping the one next to it. They are bolted to two large central discs, one on each side of the fan.

These discs, it is claimed by the builders, prevent a backward flow of air through the center when working



A MOTOR-DRIVEN VENTILATING FAN BUILT BY THE AMERICAN BLOWER COMPANY, DETROIT, MICH.

against pressure. The casing is of sheet steel and is supported from the motor frame.

The frame of the motor is of steel, cast in one circular piece. The pole-pieces are of cast steel, provided with shoes to hold the field coils in place and shaped to insure sparkless commutation.

The armature is of the ironclad, coil-wound, self-contained type, the core being of annealed sheet-steel laminations. The coils are of copper wire, form wound. The field coils are machine wound.

The commutator is large and heavy, of highest grade copper, the segments being perfectly insulated by the best grade of mica. The brush-holders are of brass and are provided with adjusting screws for varying the pressure on the commutator. Carbon brushes are used.

Open frame motors are regularly furnished, but enclosed motors can be had upon application, at an additional cost of about 33 per cent. Speed regulation is accomplished by a rheostat designed to reduce the speed approximately 50 per cent., by insertion of resistance in the armature circuit.

The resistance as well as contacts have sufficient capacity to carry the current continuously on any step, provided this current does not exceed the amount required to operate the motor. An automatic release attachment is provided, which holds the lever squarely over each segment, and opens the circuit on failure of the current supply. All rheostats are made absolutely fireproof, have highly polished marble front, and carefully finished and fitted working parts.

A New Electric Elevator

An electric elevator of a novel type, built by the Mabbs Electric Elevator Company, of Chicago, is shown in the annexed illustrations. The most prominent feature of the machine is that the motor takes the place of the counterweight ordinarily used. The motor travels up and down two vertical cast-iron columns by means of four pinions, which engage four racks on the outer faces of the columns. The pinions are mounted on the outer ends of two horizontal shafts. In the center of each of these is mounted a worm wheel, and between these wheels is a worm mounted on the armature shaft. As the armature revolves, the worm turns the horizontal shafts and pinions by means of the worm wheels, causing the motor to ascend or descend according to the direction the armature is revolved. As the motor ascends, the car descends, and vice versa.

The motor is not rigidly attached to the hoisting cables, but hangs in a bight of the cables, one end of these being attached to the building, thence passing downward around the sheave on the motor, thence up over a sheave in the attic, and then down to the car. By this arrangement the car travels two feet to every foot the motor travels. Consequently, the motor hatchway extends

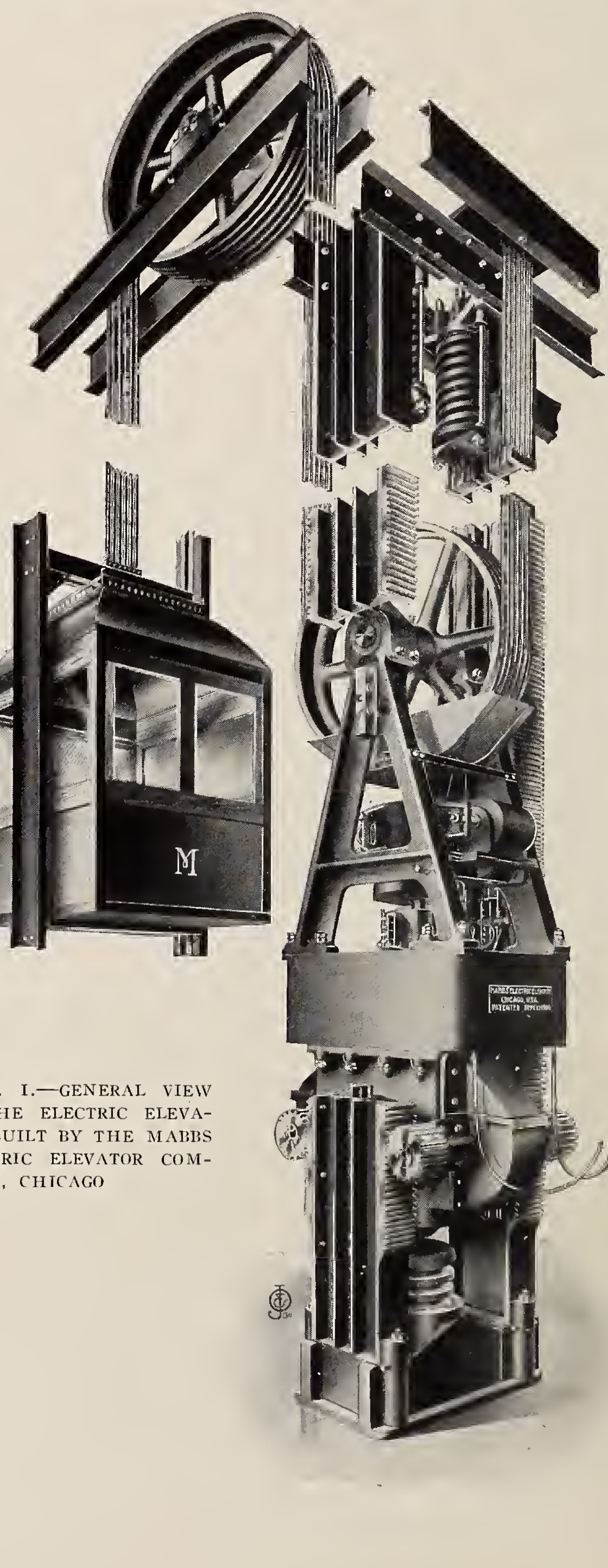


FIG. I.—GENERAL VIEW OF THE ELECTRIC ELEVATOR BUILT BY THE MABBS ELECTRIC ELEVATOR COMPANY, CHICAGO

THE CONTROLLER FOR THE MABBS ELECTRIC ELEVATOR. MADE BY THE J. L. SCHUREMAN COMPANY, CHICAGO

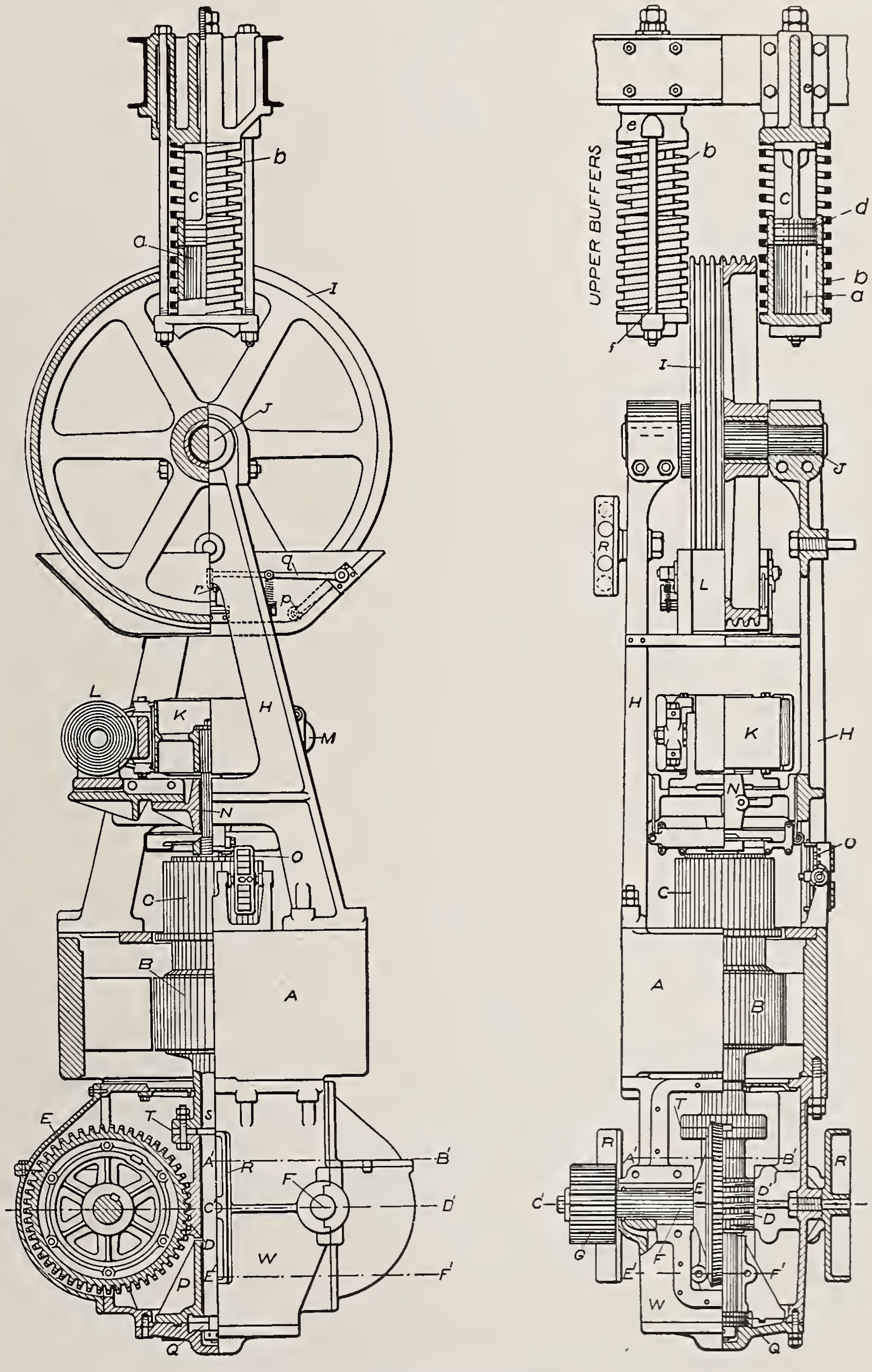
only half the height of the building. The motor runs in guides on the inner faces of the cast-iron columns. The current is carried to the motor by means of two copper-lined channels, mounted on porcelain blocks, located on the columns between the motor guides and the racks, and the current is taken from these channels by means of brushes mounted on the motor frame. At the upper and lower end of the travel of the motor are located air buffers, which form an absolute mechanical stop for the motor.

Figs. 2 and 3 illustrate the construction of the elevator. The motor frame is shown at *A*, and *B* is the armature. The motor is of the 4-pole type, with three field windings, one a light series winding, used only in starting the motor, and the second an auxiliary shunt winding, which, when cut out in steps, weakens the field. When this is all cut out, the motor runs as an ordinary shunt-motor at a speed of between 900 and 1000 revolutions a minute.

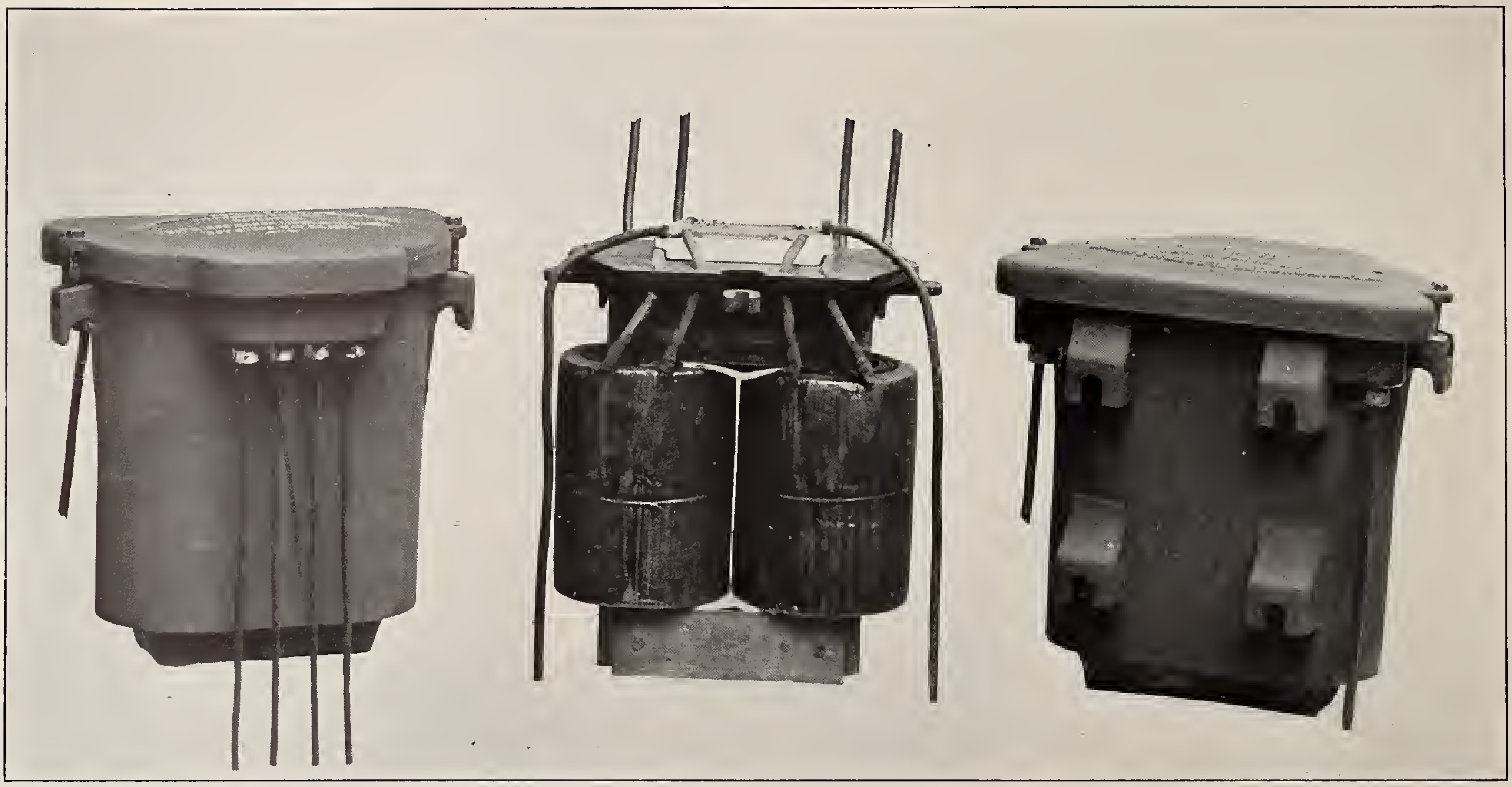
The armature shaft *S* is connected by the coupling *T* to the worm *D*, which drives the worm-wheels *E*, *E*. These wheels are keyed on the horizontal shafts *F*, *F*, on each end of which are the pinions *G*. These pinions engage the rack on the cast-iron columns.

The brake pulley *K* is mounted on the upper end of the armature shaft. The brake-shoes which grip this pulley are held off by the action of the solenoid *L*, and are applied by means of a spring *M* whenever the current is shut off by the operator or by accident.

The trolley brushes *O*, *O*, press against small steel channels lined with a copper bar, and supported on the columns by porcelain blocks, a leather washer being placed between the blocks and the columns to prevent breakage. The cast-iron columns support the racks and form the guides for the motor and the structure up and down which the motor operates. These columns are I-beam in shape, being heavily ribbed both vertically and horizontally, the two vertical ribs on the inner faces forming the guides for the motor. The columns are made in lengths of 12 feet, and are bolted and



FIGS. 2 AND 3.—SIDE AND FRONT ELEVATIONS OF THE MABBS ELECTRIC ELEVATOR



A CORE-TYPE TRANSFORMER RECENTLY PLACED ON THE MARKET BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURGH

doweled together to insure perfect alignment. They are designed with sufficient strength to operate an elevator in a building of over 600 feet in height, and are mounted upon a very heavy base, which also forms the lower buffer.

The controller used is manufactured by the J. L. Schureman Company, of Chicago. It is controlled from the hand switch in the car, from which the operator can obtain any one of three speeds. If the switch lever is moved to the extreme right or left, the car is gradually but quickly brought to its highest speed. When the operator moves the lever back toward the center position, two sections of resistance in the circuit of the shunt fields are consecutively short-circuited, thereby reducing the speed of the car to normal. Then the main line circuit is opened and the armature is short-circuited through a bank of resistance. The speed of the motor is thereby reduced to a minimum, but the car will still move slowly until the car switch is moved to the center position, when the circuit to the brake solenoid is opened and the brake is set, bringing the car to a stop. With this arrangement, it is claimed, it is possible to obtain almost any variation within the limits of speed, allowing smooth and easy stops at the landings, and quick acceleration in starting.

Multiple magnet switches are used throughout in the construction of this controller, all contacts being vertical, thereby preventing the accumulation of dust. A double-pole magnet switch equipped with carbon and copper contacts is used to make and break the main line circuit, blow-out magnets being used to prevent all arcing. The reversal of the direction of travel is obtained by means of two double-pole interlocking magnet switches controlling the supply of current to the armature. The armature resistance is short-circuited by means of a series of single-pole magnet switches mounted on the bottom of the controller panel. These switches are controlled by a master solenoid shown in the upper right-hand corner of the panel. Each switch drops out as its successor is pulled in until only the last of the series remains closed.

The average current consumption of this elevator for a period of two years, running at a speed of 576 feet a minute on express service, stopping at five out of nine floors,, was, it is claimed, 3-43 KW. per car-mile.

A New Core-Type Transformer

A NEW core-type transformer recently placed on the market by the Westinghouse Electric & Manufacturing Company, of Pittsburgh, is shown in the annexed illustration.

These transformers are intended for general distribution service on 60-cycle circuits operating nominally at 1050 and 2100 volts, although they will operate successfully on voltages up to 1200 and 2400. They are manufactured in sizes from 0.6 to 50 KW., all wound for the same primary voltages but divided into classes according to the voltages of the secondary. Class 200 may be connected for either 105 or 210 volts, and class 400 for 210 or 420 volts.

The transformer is enclosed in a cast-iron case with felt gaskets under the lid, so as to make the transformer absolutely weather-proof. For sizes above 20 KW. the case is corrugated to increase the radiating surface, but in the smaller sizes a smooth case has surface sufficient to radiate the heat generated. Hanger irons are provided by which any transformer up to and including 30 KW. may be mounted on a pole.

The core of the transformer is built up of carefully annealed steel punchings, and is practically non-aging. The primary and secondary coils are placed on the long sides of the core, the laminations of which are clamped together at top and bottom by suitable end frames. The low-tension winding is composed of one coil per leg, each coil having two sections so connected that the inner section of one leg is in series with the outer section of the other leg. This arrangement results in a secondary winding of two exactly similar parts, both as to resistance and reactance, and insures equal loading of each primary coil irrespective of the method of loading the secondary. A balanced voltage is thus maintained

on the two sides of a three-wire distributing system irrespective of the load. The high-tension winding is divided into two coils per leg to reduce the voltage between layers of the winding to a low value.

The core-type construction allows the use of a circular coil, which has many advantages. All insulating parts between layers of the winding and between high and low-tension coils are cylindrical in form, eliminating sharp corners harmful to insulating material. The windings are so disposed and oil ducts so provided that a free circulation of oil between coils and core is obtained, insuring ready dissipation of the heat and preventing deterioration of the insulation. Very careful attention has been paid to the insulation, and liberal allowances made to insure a high factor of safety.

Consolidation of Trolley Lines Around the Great Lakes

A COMBINATION of trolley lines around the Great Lakes was recently effected in the incorporation at Trenton, N. J., of the Tractional Company, with an authorized capital of $100,000. The primary object of the company was to take over the International Traction Company, which controls the street car lines in and around Buffalo, Niagara Falls and Lockport, but the charter permits it to acquire other properties. It is also closely identified with the combination of street car builders now under way.

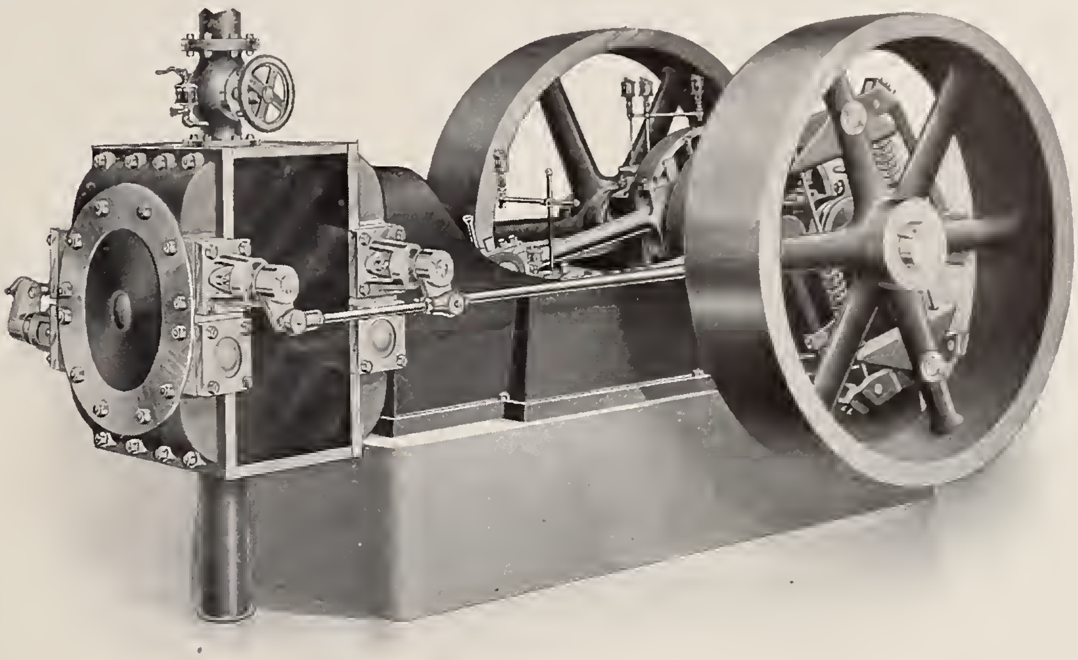
At the present time trolley lines are being built from Rochester to Buffalo and from Buffalo to Cleveland. Lines already are in operation from Cleveland to Toledo and from Toledo to Detroit. The New York Central & Hudson River Railroad is supposed to have an interest in the Rochester-Buffalo line, but the other lines are independent.

The banking firm of Kean, Van Cortlandt & Co., which has a very large interest in the new concern, controls the traction lines of Detroit and the traction lines and lighting companies of Toledo, and are the syndicate managers of the car builders' combination, which embraces nineteen of the largest car builders of the country.

The Tractional Company and the banking firm identified with it control terminal facilities in Buffalo, Toledo and Detroit, and contracts have already been made with the independent lines running between those cities, and between Rochester and Buffalo.

A New Four-Valve Engine

A NEW type of four-valve engine recently placed on the market by the Atlas Engine Works, of Indianapolis, is shown in accompanying illustrations. Chief among the improvements is the placing of the steam and exhaust valves directly in the cylinder heads, rather than at the top and bottom of the cylinder, as is the custom. This construction is well shown in Fig. 2, and is claimed to effect a reduction of practically 4 per cent. in the clearance. It also involves keeping the entire top of the cylinder and the upper portion of both heads constantly in contact with live steam, in this way greatly reducing the loss from cylinder condensation.

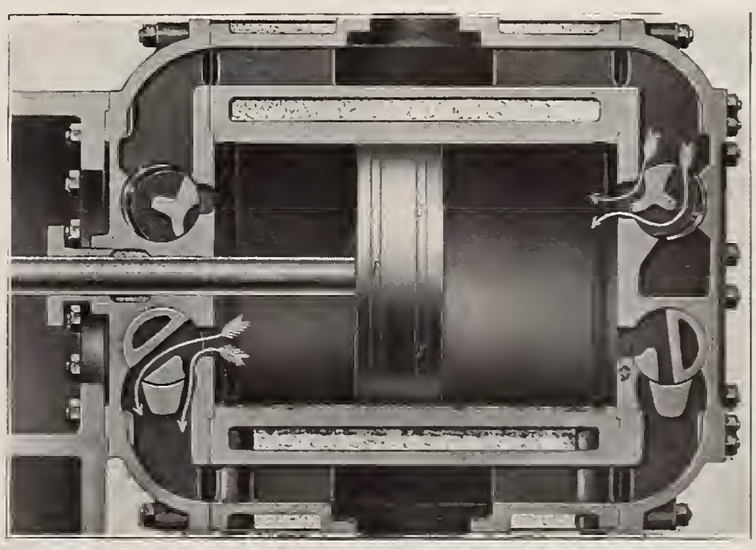


A NEW FOUR-VALVE ENGINE BUILT BY THE ATLAS ENGINE WORKS, INDIANAPOLIS, IND.

The bell crank and toggle joint common to practically all existing types of four-valve engines have been entirely done away with, and a great deal of the lost motion which they invariably entail has in this way been eliminated. The steam valves are operated directly from a movable eccentric forming a part of the automatic shaft governor, and are entirely independent of the exhaust valves. The latter are operated from a fixed eccentric on the main shaft, in this way insuring uniformity of compression under all conditions of load and pressure. The connections are all of the "straight-line" type, and involve no multiplicity of parts.

Both the steam and exhaust valves are double ported, and it is claimed that practically no wire drawing of steam whatever exists in this type of engine. Various tests made in the Atlas shops, as well as elsewhere, indicate a steam consumption practically identical with that of the Corliss type, and a regulation of from 1 to $1\frac{1}{2}$ per cent. under changes of load from friction to full rated capacity.

In addition to the line of medium-speed engines, the builders are also offering a high-class center-crank engine for electrical service. This type has the reciprocating parts enclosed under an oil-tight hood. At each revolution of the shaft, the crank, crank-pin, cross-head pin, cross-head guides and main bearings are showered with oil from a reservoir in the crank pit, into which the connecting rod dips. Oil from the same source is also delivered by centrifugal force to all other reciprocating parts, and is finally returned to the reservoir in the crank pit.



SECTION OF CYLINDER OF THE ATLAS FOUR-VALVE ENGINE

Self-Starting Single-Phase Motors

A SELF-STARTING, single-phase motor built by the Century Electric Company, of St. Louis, Mo., is shown in the annexed illustrations. This motor is self-starting under full load, the only device necessary to start or stop it being an ordinary double-pole, single-throw, knife switch. No auxiliary conductors, compensating transformers, phase coils, clutches or clutch pulleys are employed.

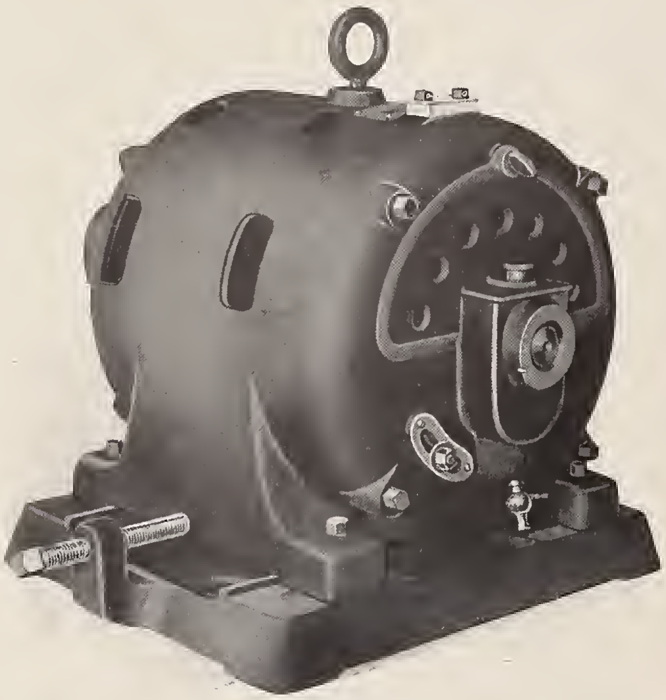


FIG. 1.—A SINGLE-PHASE, SELF-STARTING MOTOR BUILT BY THE CENTURY ELECTRIC COMPANY, ST. LOUIS, MO.

While running up to speed, the induced current in the armature is short-circuited through carbon brushes bearing on the commutator and so situated with relation to the field as to control the direction of rotation and the amount of starting torque. On reaching full speed the governor weights are thrown out, due to centrifugal force, short-circuiting every commutator bar to one common ring of high conductivity, and at the same time releasing the tension on the carbon brushes, pushing them back away from the commutator and allowing the motor to run as an induction motor.

This device is very simple in construction and not likely to get out of order, being entirely protected and located inside the armature, the weights only being outside and on the end of the armature, as shown in Fig. 2. The governor is entirely automatic, and when the motor is stopped the device returns to its starting position.

The commutator is in service only during the period of starting, ranging from 5 to 20 seconds, depending on the load. As the motor is entirely automatic and can be started from a distance by closing either the primary or the secondary of the supply circuit, it is especially adapted to the operation of irrigating or house-pumping outfits, air compressors or refrigerating machines, arranged to be started or stopped by means of a float switch, pressure regulator, or any other automatic device serving to close the supply circuit.

If suddenly overloaded, this motor will return to its starting position and will automatically take care of such overload at a slow speed, if this overload is not continued through too long a period. As soon as the overload is removed, the motor will at once come up to full speed.

It is adapted to operating any kind of machinery not requiring very frequent stopping and starting or speed variation through the motor. Where the former is necessary, it is recommended to use tight and loose pulleys and allow the motor to run, as, it is claimed, it is very economical in current consumption at no load.

Standard motors, it is claimed, will be found capable of bringing a load up to speed equal to about $1\frac{1}{3}$ of their rated capacity, although on special orders they may be constructed so as to be capable of bringing up to speed a load much in excess of this. When connected directly across the line, as shown in Fig. 3, which is the usual manner of making the installation, they will develop at the moment of starting two and one-half times full load torque, but by the time the motor has reached one-quarter speed, the torque will have increased to five times full load torque and the current decreased to double full load current, both torque and current gradually diminishing to normal as the motor comes up to speed. The starting torque and starting current may be materially reduced by the position of the brushes on the commutator relative to the field.

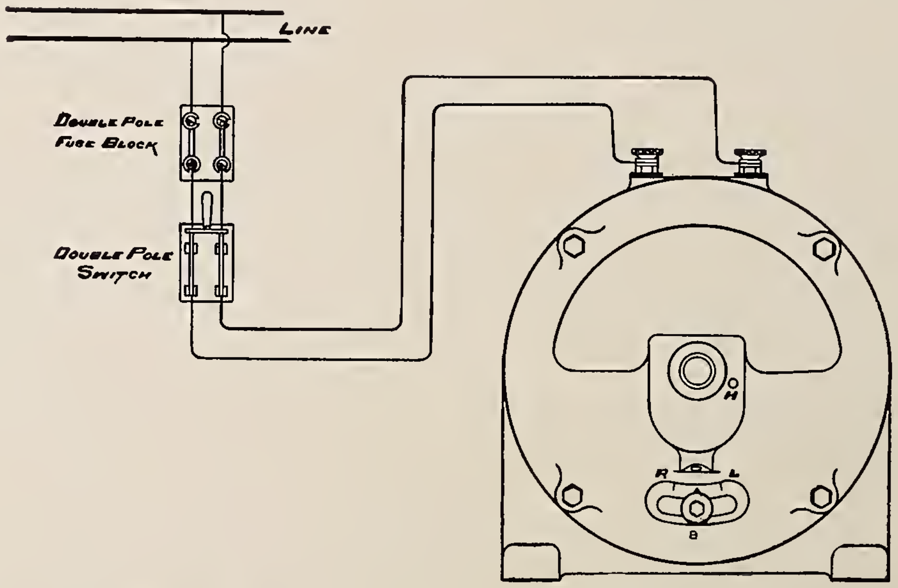


DIAGRAM SHOWING LINE CONNECTIONS OF CENTURY ELECTRIC COMPANY'S SINGLE-PHASE MOTOR

Where it may be necessary to hold the starting current down to full load current, this may be accomplished by the use of an ordinary direct-current motor starter, connected in series with the motor. Any of the standard forms of starters may be used for this purpose by taking out the spring in the contact arm and leaving the automatic release magnet out of service. A starter should be selected for a motor for the next larger size

FIG. 2.—PARTS OF THE SINGLE-PHASE, SELF-STARTING MOTOR BUILT BY THE CENTURY ELECTRIC COMPANY

than the motor it is to be used with. The company will supply non-inductive starters specially constructed when desired.

Standard motors of from ½ to 10 H. P. are carried in stock for 104 and 208 volts, and they can be operated on either of these by changing the connections. They are wound for other voltages on order and for frequencies between 25 and 133 cycles. Special designs with a back-geared shaft and gears mounted on the side of the frame can also be furnished, as well as those of the vertical or enclosed dustproof type.

Personal

Factory welfare engineering, if it may so be termed, is the work to which H. F. J. Porter, until recently second vice-president of the Nernst Lamp Company, will devote himself. To that end he has established himself in the Metropolitan Building in New York City. Mr. Porter's experience thus far, during an active professional career of about twenty-five years, has fitted him exceptionally well for this unique field of work, of which the importance has of late rapidly grown, until the services of a man like Mr. Porter are pretty certain to be in demand in many places. In connection with the development of the Nernst Lamp Company's operations, Mr. Porter, who, for many years previous, had been in daily contact with working men and women in various branches of engineering work, had excellent opportunity to carry his industrial

H. F. J. PORTER

betterment, or factory welfare, ideas into execution, and this he did with marked success. Increased efficiency of employees, due to contentment with their surroundings and appreciation of an employer's solicitude in their behalf, is of course the end sought in such work, and Mr. Porter's business is to demonstrate practically that this end is attained, and that it represents a distinct money gain to the employer. Mr. Porter, by the way, is the eldest son of the late General Fitz-John Porter, U. S. A., and is a graduate of Lehigh University, where he received the degree of Mechanical Engineer in 1878.

Dr. F. A. C. Perrine, 49 Wall Street, New York, has decided to go extensively into isolated plant work, covering the general engineering and operating problems of electric lighting, power development and operation, thus affording to the small company or corporation the advantages of a well-equipped engineering office at a comparatively moderate fee. Dr. Perrine will be assisted in this work by Mr. Edwin H. Seaman, who will attend to its minor details.

James Stowell Anthony, of the General Electric Company, was married to Miss Alys P. Scott, daughter of Mr. and Mrs. Alfred Bowne Scott, on August 15. The wedding took place at Geneva, Switzerland. Mr. and Mrs. Anthony will return to this country early in the fall and will reside in New York.

Thomas A. Edison is represented as having recently said that his new ferro-nickel storage battery, upon which he has been experimenting for some years, will be ready to put upon the market in perfected form by October 1.

W. S. Doran, formerly associated with the British Westinghouse Electric & Manufacturing Company, Ltd., has just been appointed manager of the power department of the Allis-Chalmers Company, in which capacity he will have complete charge of the company's commercial affairs pertaining to reciprocating steam engines, steam and hydraulic turbines, condensers, gas engines, blowing engines for iron and steel blast-furnace service, and rolling-mill engines, with headquarters at the general offices of the Allis-Chalmers Company, Milwaukee, Wis. With his thorough training and varied experience, Mr. Doran is excellently qualified to carry on this large and important work. He brings with him not only the knowledge acquired in some of the larger manufacturing concerns in

W. S. DORAN

this country, but also the wide scope of technical training gained during the many years he has spent abroad. He started on his business career with the Southwark Foundry & Machine Company, of Philadelphia, where he remained five years, engaged in drafting and general shop work. After spending some time with the United Gas Improvement Company, of Philadelphia, in the construction and management of water-gas plants for that company, he became connected with Henry R. Worthington, with whom he remained for many years, having headquarters in New York, Chicago and Philadelphia, being largely occupied in negotiating with the United States Navy for pumping plants for war vessels. In addition to his engineering duties, he had charge of the branch offices, and while located at Chicago had complete charge of their entire Western business. In 1899 he joined the Worthington Pumping Engine Company, Ltd., with headquarters in London, England, where he took charge of their various branch offices and the important negotiations in Great Britain and Ireland. In 1901 Mr. Doran became associated with the British Westinghouse Electric & Manufacturing Company, Ltd., and since then has been establishing their branch offices and supervising their sales. In that capacity he has conducted a large number of important negotiations successfully with steam railway companies, power distribution companies and street railway lines. Notable among the large contracts secured by Mr. Doran, may be mentioned the complete installation of

the power and lighting plant for the Midland Railway Company, at Heysham Harbor, comprising the complete installation of buildings, gas engines, generating-plant producers, transmission lines, electric cranes and other minor accessories. The new Belfast, Ireland, tramways and several large iron and steel works plants were successfully negotiated by him. Mr. Doran has mastered the intricacies of the commercial side of large manufacturing establishments, as well as the engineering end of the business. He has a delightful personality, to which no small measure of his success may be attributed. As an evidence of the high esteem with which Mr. Doran is regarded by his business associates, a banquet was tendered him on the eve of his departure from England, attended by many well-known railway officials, manufacturers, electrical engineers and representatives from practically all the large electrical manufacturing concerns in England.

At the annual meeting of the stockholders of the Allis-Chalmers Company, held at Jersey City on September 7, Edward D. Adams, of New York; Mark T. Cox, of East Orange, N. J.; Edmund C. Converse, of New York; Joseph S. Neave, of Cincinnati, Ohio, and Edwin Reynolds, of Milwaukee, Wis., were elected directors. At a subsequent meeting of the board of directors, Walter H. Whiteside, of Milwaukee, was elected president, to succeed Benjamin H. Warren, of New York, and Henry Woodland, of Milwaukee, Wis., was elected treasurer, to succeed Wm. J. Chalmers, of Chicago. Mr. Whiteside came to the Allis-Chalmers forces last year from the Westinghouse Company, where he was manager of the detail and supply department and, at the same time, general manager of the Sawyer-Man Electric Company. His work there showed marked executive ability, and in the twenty-five years of his business activity he has become one of the best-known men in the country identified with the business ends of the great industrial companies. Mr. Warren, it is understood, will become the head of a new engineering and contracting company in New York.

Walter E. Harrington has severed his connection as vice-president and general manager of the New York-Philadelphia Corporation to become associated with J. G. White & Co. of New York, as operating manager. Mr. Harrington has had an exceptionally broad experience in the engineering field, particularly in the operation of electric railway, lighting and gas properties. After graduating from the University of Pennsylvania in 1887, he became associated with W. G. Griffith in the electrical contracting business. For two years he was electrical engineer for the Pennsylvania Railroad in charge of the electric railway at Atlantic City, N. J., following which he was appointed general superintendent of the Wheeling Traction Company and the Citizens Railway Company, of Wheeling, W. Va. This was one of the early electric railways using the Van Depoele motors on the front platform. The General Electric Company then secured his services as supervising engineer in the coal regions of Northern Pennsylvania. He then became general manager of the Cutter Company, of Philadelphia, having charge of all their electrical installations. For several years he acted as consulting engineer for a number of railway systems, supervising the change from horse to electric power. In 1896, he was appointed general manager and vice-president of the Camden & Suburban Railway Company, remaining with them until the company was absorbed by the Public Service Corporation of New Jersey. In 1904 he was placed in charge of all the railway properties south of Trenton, N. J., under the Public Service Corporation, and in 1905 assumed charge of the New York-Philadelphia Corporation as vice-president and general manager. Mr. Harrington is an active member of the executive committee of the American Street Railway Association, and a member of the American Institute of Electrical Engineers. As operating manager of J. G. White & Co., he will supervise all of the railway, electric lighting, gas, and other properties operated by it, and will make his headquarters at the New York office of the company.

W. E. HARRINGTON

George Westinghouse was among recent arrivals from abroad. Of Mr. Westinghouse, by the way, a biographical sketch is given in the current number of the "American Illustrated Magazine," in which it is stated that, at 59 "he stands as the originator, organizer and responsible directing head of industries employing thirty thousand persons, on whom seventy-five thousand more are directly dependent, and indirectly supporting twenty-five thousand persons in addition to these. None but the German manufacturer, Krupp, comes to mind as equaling Westinghouse in industrial importance. Where Krupp built with destruction in view, the genius of Westinghouse ever has been directed to improving and enlarging the arts of peace. The financier whose manipulations in the field of speculation give a false value to securities of doubtful merit, who, when he has boosted prices to an attractive figure, steps from under after pocketing the profit of the faith of the public, may be of some use as a patron of the arts and gentleman sports, as the supporter of great private estates, as a generous tipster of menial servants, and in other ways in which money may be prodigally kept in circulation, but does he compare in usefulness with the great nurseryman who conceived and fostered and today guides and controls the parent plant and the spreading branches of the Westinghouse works?"

Howard S. Reynolds, superintendent of the operating department of J. G. White & Co., of New York City, has resigned to assume the management of the electric light, street railway and gas properties in the city of Helena, Mont. These properties have recently been acquired by the White company and allied interests, and Mr. Reynolds' promotion to this important post is evidence of the confidence reposed in him.. Mr. Reynolds graduated from the Massachusetts Institute of Technology in 1894 with the degree of B. S. The following year was spent with the Lowell, Lawrence & Haverhill Street Railway, after which he was with the Boston Elevated Road and the Brockton Street Railway in various capacities. For 6 years Mr.

Reynolds was with Stone & Webster, first as draughtsman and street railway construction superintendent, and later as manager of their street railway, electric lighting, and gas properties in Columbus, Ga., which position he resigned to become associated with J. G. White & Co. Mr. Reynolds' extensive experience in the management of electric lighting, railway and gas properties has eminently qualified him for the position he has accepted at Helena.

President Blood, of the National Electric Light Association, has appointed the following gentlemen as the committee on standard rules for electrical construction and operation: —Ernest H. Davis, chairman; Captain William Brophy, Louis A. Ferguson, Alex Dow and Samuel Scovil. The chairman, Mr. Davis, is past president of the association, and took an active interest in the work of the committee last year. All of the other gentlemen have been in close touch with this question for some time, so the association will be represented by men who are thoroughly conversant with the subject.

William Randolph Strickland has resigned from the New York Central Railroad and is now associated with Messrs. J. G. White & Company, of New York, as assistant to the secretary. Mr. Strickland is a graduate of the Massachusetts Institute of Technology and during the Spanish War served at the Mare Island Navy Yard as assistant engineer. While on the U.S.S. "Bennington" as assistant engineer he had charge of the operation, maintenance and repair of all the machinery about the ship. After the war Mr. Strickland was employed by the Blake Pump Company and Buckeye Engine Company as draughtsman, and also in designing special electric cranes and controllers for the Case Manufacturing Company in the capacity of assistant and also as chief engineer. Mr. Strickland made the hydraulic calculations for the North Fork power house scheme at Denver, Col., in 1900. After he had completed this work he joined the staff of the Colorado Fuel & Iron Company as engineer of location on a standard-gauge line over McClure Pass. He also located several electric and steam narrow-gauge lines in Colorado. In 1902 Mr. Strickland was appointed designing engineer for the Lannius Machine Company, and in that capacity laid out its combined amalgamator, concentrator and arrestor. In 1903 he was appointed location engineer on the New York Central Railroad and supervised the extensions from Cherry Tree to Possum Glory, as well as several of their double-tracking and grade-revision schemes. For the past year Mr. Strickland has been assistant engineer in the maintenance of way department, handling correspondence from all divisions in regard to the repair and construction of bridges and buildings. Mr. Strickland's headquarters will be at the main offices of J. G. White & Company, 43 Exchange place, New York.

William B. Hale, president of the Electrical Section of the Western Society of Engineers, has accepted a position as general manager of the Mexican Telephone & Telegraph Company, with headquarters in Mexico City. Mr. Hale, who leaves behind him a host of friends, received his education at the University of Toronto, and took a course in electrical engineering at the School of Practical Science in the same city. Shortly after graduation he removed to Chicago, accepting a position with the Sperry Electric Mining Machinery Company. In 1890 Mr. Hale entered the employ of the Western Electric Company at Chicago and was continuously associated with that company up to the present time, having had complete charge of the testing laboratories and cable testing rooms for sometime past. Mr. Hale has had a wide experience in underground cable work, having superintended the installation of the cable systems in a number of cities. He was for several years secretary of the Chicago Electrical Association and was elected to the presidency in 1904, shortly before the union of that body with the Western Society of Engineers, a movement in connection with which he was largely instrumental. He was elected chairman of the Electrical Section of the Western Society of Engineers in January of this year. Mr. Hale is 37 years of age. He was married in 1897. His ability to speak Spanish and French will be of considerable use to him in his new position.

G. M. Basford, for the past eight years editor of "The American Engineer and Railroad Journal," has accepted a position with the American Locomotive Company in charge of a newly established department of publicity. He will assume his new duties October 1, at the general offices of the company, 111 Broadway, New York.

About three seconds are required in sending a message from one end of the Atlantic cable to the other.

Trade News

The latest addition to the list of reinforced concrete power houses is that being built for the Waltham Gas Light Company, Waltham, Mass., by J. G. White & Co., of New York City. The entire building is to be reinforced concrete construction. No exposed steel framework will be used. The design calls for very large windows, thus insuring ample light and ventilation. Steam will be supplied by four 350-H. P. Sterling boilers, set in batteries of two each, an 8-foot 6-inch by 180-foot, reinforced concrete stack furnishing natural draft. Suspended coal bunkers occupy the upper half of the boiler room. These are filled by coal conveyors. Chutes from the bunkers, operated by valves from the boiler room floor, feed the coal to the boilers. Two 500-KW. Parsons turbo-generators, direct connected to Westinghouse dynamos, form the main engine equipment. The White company are rushing the work, and when completed the Waltham Gas Light Company will have an electric power station which, for fire-proof qualities and low operating cost, it will be exceedingly difficult to surpass.

The J. G. Brill Company, of Philadelphia, has received an order from the United Railroads of San Francisco for 200 short-base double trucks, having the Brill system of equalization, which in this particular type consists of semi-elliptic equalizers carrying a truss form of bolster at either end, and suspended from the side frames by spring links at wide-apart points close to the yokes. Each side frame is solid forged, and the angle-iron transoms are secured to the side frames with forged double and single-corner brackets. The brakes are usually inside hung.

The Chandler & Taylor Company, engine builders, of Indianapolis, Ind., were the successful bidders for the 150-H. P., high-speed, self-oiling, direct-connected engine which is to be placed in the large new power plant of Messrs. Mandel Bros., of Chicago, Ill.

The Pennsylvania Steel Tie Company, a new undertaking, has applied for a charter and will have its offices and plant in Pittsburgh. The incorporators are W. W. Mechling, Jacob E. Smith and Frederick Howden, all of Homestead, Pa. Mr. Mechling has been connected with the Carnegie Steel Company for ten years as a department superintendent at the Homestead Steel Works, and has in-

vented a steel tie for which patents have been granted. The incorporators propose to build a plant in the Pittsburgh district for the manufacture of these ties. It is stated that a number of railroads have experimented with sample ties in the past year and that they have given entire satisfaction.

Messrs. John H. Fowler & Co., Fisher Building, Chicago, are understood to control at present the largest stock of cedar poles in the West, having recently added about 50,000 poles to their Idaho stocks. They have also opened a branch office in the Exchange Bank Building, at Spokane, Wash., in charge of C. W. Gregory.

The Morse Chain Company, located at Trumansburg, N. Y., are now building at Ithaca, N. Y., a plant of about five times the present capacity. The company was incorporated in 1898, F. L. Morse being the treasurer and general manager. The plant was originally started for the manufacture of bicycle chains, but in 1901 they bought out their present high-speed silent chain, and since that time have had a rapidly growing business. In the line of power transmission the Morse Company have in service chains transmitting over 75,000 H. P., and are furnishing drives up to 500 H. P. for a single transmission.

Baker & Company, Inc., refiners and manufacturers of platinum, of Newark, N. J., and New York City, are making extensive additions to their Newark works. The rapidly increasing consumption of platinum in the industrial arts has made this extension necessary, especially in their refining department, which will be enlarged over 100 per cent. New and larger offices are also being erected, and the entire plant equipped with the most modern appliances for the economical manufacture of their varied and high-grade products.

Messrs. J. G. White & Co. and associates have acquired the street railway, electric lighting, and gas properties at Helena, Mont., known as the Helena Light & Traction Company. Howard S. Reynolds, superintendent of the operating department of J. G. White & Co., has been appointed manager of the company. Control of these interests was acquired only after a careful examination by the engineers of J. G. White & Co., the result of which has satisfied them that in this progressive Western city there is an excellent opportunity for expansion and growth in the railway, lighting, and fuel business. The electric railway system of Helena consists of about 17 miles of line, the greater portion of which is single track. There is an attractive amusement park operated in conjunction with the road. Current for both the street railway and the electric lighting system is supplied by the Missouri River Power Company. The incandescent and alternating power distribution is three-phase, 60-cycle, 220-volt, and rotaries installed in the sub-station provide a direct-current power system of 550 volts for elevator motors, etc. The city lighting service consists of a series alternating enclosed-arc system, with 6.6 ampere lamps. The business and residential sections are well covered, but extensions are contemplated. Flat and meter rates are in vogue for electric lighting. Motor rates for lighting are from 15 to 18 cents per kilowatt-hour, and power rates from 7 to 9 cents per kilowatt-hour. The sub-station contains two motor-generators sets and two rotary converters, and from this station power is distributed on overhead lines. Gas is manufactured in a modern plant and distributed through approximately 15 miles of mains.

New Catalogues

A steam-engine catalogue, larger and more complete than that mentioned in these pages last month, was recently sent out by the Ball Engine Company, of Erie, Pa. The engines illustrated are of the horizontal single and compound type and of the horizontal and vertical Corliss type, single and compound. Illustrations are also given of some of the details, with sectional views of the cylinder and valve chest of both the single-valve and the Corliss types.

A large variety of power pumps for every kind of service is illustrated and described in a 192-page catalogue recently sent out by the Gould Manufacturing Company, of Seneca Falls, N. Y. The greater number of the pumps illustrated are of the plunger type, but rotary and centrifugal pumps are also dealt with. They are shown arranged for belt, electric-motor, gas-engine, or steam-engine drive. A number of automatic, electric controlling devices are illustrated, and also gate, check, and water relief valves, gauges and friction clutches. A number of tables are given of the power required to operate the various types of pumps, the friction of water in pipes, head and equivalent pressure, horse power transmitted by shafting and by belting, and metrical equivalents of weights and measures.

A new catalogue on common battery, non-multiple switchboards, recently sent out by the Kellogg Switchboard & Supply Company, of Chicago, Ill., is a creditable piece of work. The engravings are well executed, and the diagrams, seldom attractive in any catalogue, are, in this case, unusually so. Exchanges without central office connections are first taken up, followed by those with central office connections or private branches. Line-circuit and operator's circuit apparatus are next described, the various details being illustrated. The remainder of the pamphlet is taken up with common-battery switchboard cabinets, operator's chairs, a two-party selective system, power equipment, and switchboard protectors. A number of illustrations are given of installations.

New testing instruments for measuring resistance are illustrated and described in a folder recently sent out by Queen & Co., of Philadelphia. The list comprises portable sets for cable testing and for general use, current indicators, resistance boxes, mica condensers, slide-wire bridges, and detector galvanometers.

A novel form of butterfly hot-water radiator valve is illustrated and described in a circular recently issued by the Crane Co., of Chicago. It is operated by the foot and requires but ¼ turn to open or close it. Other circulars issued deal with sectional and solid pipe dies, automatic exhaust relief valves, combination back-pressure and exhaust relief valves, and flanged pipe joints, respectively.

Small single-phase induction motors, of 1-8 and 1-6 H. P., are dealt with in a bulletin recently sent out by the Emerson Electric Manufacturing Company, of St. Louis, Mo. They are providied with starting coils and an internal centrifugal clutch. The latter allows the motor to turn freely on the shaft until it has reached a sufficient speed and is developing approximately full power, when the clutch engages the shaft, thus starting the load. Another bulletin deals with flat and round-belt pulleys for use with these motors.

Three bulletins recently issued by the General Electric Company, of Schenectady, N. Y., are devoted to type C. Thomson recording wattmeters, electrically driven turbine house pumps, and service cut-outs,

respectively. An index to bulletins already issued is given in a separate pamphlet. A little pamphlet on "coffee making by electricity" illustrates the company's electric coffee percolator and describes its operation. A series of flyers also sent out deal respectively with Edison socket rings, porcelain ceiling, boards, pendant switches, enclosed fuse cut-outs, combination service switches and cut-outs in iron boxes, combined switches and enclosed fuse cut-outs for car lighting, ceiling rosettes with enclosed fuse, 15-ampere, 125-volt, double-pole, knife switches, and speed-controlling rheostats for use with variable-speed, shunt or compound-wound motors. Other literature issued consists of a pamphlet on repair parts of hangers and cut-outs for forms 2 and 3 arc lamps, price lists of types H and HB oil transformers, and a blotter illustrating automatic circuit breakers.

Gas producers built by the Morgan Construction Company, of Worcester, Mass., are illustrated and described in a catalogue recently issued. A sectional view shows the construction of the producer and illustrations are given of plants installed by the company. An automatic feeding device is also illustrated and described. This is operated by a ratchet and pawl arrangement, driven from a line shaft by means of an eccentric and rod, the shaft being driven by an electric motor through a worm and wheel. An electrically operated crane, for changing the buffers, is also illustrated. The operation of the producer and the quality of the product are fully discussed, and the results of tests of a plant in commercial operation are given.

Vertical motors built by the Northern Electrical Manufacturing Company, of Madison, Wis., are a recent development in electrical equipment for vertical-shaft drive. The designers have sought to eliminate the trouble due to lubrication of the vertical shaft. The equipments supplied by the company are so arranged as to prevent oil spilling from the bearings and falling on the commutator and the driven machine. A bulletin issued by the company illustrates some novel arrangements of these motors.

A new catalogue sent out by the Ward Leonard Electric Company, of Bronxville, N. Y., describes motor-speed controllers for ventilating-fan duty. Illustrations are given with diagrams of connections showing all internal connections of the controllers. Tables of resistance, capacities, and the like are also given. One sheet is devoted exclusively to specifications. These controllers have an interlocking overload circuit breaker, a no-voltage release, renewable segments, self-aligning renewable skate-shoe contacts, and an independent make and quick-break device, which prevents arcing upon the first contact.

An Automobile School

THE Manhattan Automobile School was recently opened in the city of New York. One of the purposes of the school is to train mechanicians in the operation, care, upkeep and repair of the automobile and its accessories, and to produce chauffeurs who can keep a good car going the year round.

The equipment contains automobiles for taking apart, reassembling, introducing troubles into, and general indoor instruction; also machines for road use. The instructors will show by demonstration the troubles to which automobiles are subject, then trouble will be introduced into a machine, and each man in turn required to locate it and either apply the remedy or explain how to apply it according to its nature. Each trouble will be dealt with in turn by every man.

One hundred hours of attendance will be required in the regular course, extending over a period of either four or eight weeks, at the option of the student. Both day and evening classes will be conducted. A certificate will be given those who have completed the entire course satisfactorily.

All instruction will be given under the immediate direction of Forrest R. Jones, assisted by Edward J. Kunze, both of Cornell University.

According to a paper read before the British Chemical Society, if a radium preparation and any flat object are brought for a few minutes into the immediate neighborhood of an electrified ebonite plate, and the latter is dusted with a finely-divided mixture of sulphur and red lead, a sharply-outlined dust figure of the object is formed on the ebonite plate. It is not necessary that the object should be in contact with the ebonite plate, nor with the radium preparation. If the latter is placed on the opposite side of the plate, the figures make their appearance. This is attributed to the existence of a special force which attracts the electrical charge of the plate towards the object in its vicinity.

The Association of Edison Illuminating Companies

The Lake Champlain Meeting

THE twenty-sixth convention of the Association of Edison Illuminating Companies was held at the Hotel Champlain, Bluff Point, Lake Champlain, N. Y., September 12, 13 and 14.

The following papers were presented:—

Practical Experiences with Steam Turbines," J. A. Radford, Chicago.

"Improvements in Steam Turbines," W. LeRoy Emmet, Schenectady.

"Data on Various Manufacturing Requirements," E. W. Lloyd, Chicago.

"Refrigeration by Means of Electric Motors," G. W. Goddard, Philadelphia; H. K. Mohr, Philadelphia.

"Experiences with Tests on all Kinds of Lamps for the Past Year, Including Nernst Lamps," Dr. C. R. Sharp, New York.

"The International Electrical Congress at St. Louis," J. W. Lieb, Jr., New York.

"Magnetite Lamps and Mercury Vapor Arc Lamps and Mercury Arc Rectifiers in Connection with Electric Light and Power Service," C. P. Steinmetz, Schenectady.

"Methods of Starting up Large Interconnected Systems Quickly after Partial or Total Shutdown."

"Instruction and Training of all Operating and Construction Men who work on High-Potential Apparatus and Construction," W. F. Wells, New York.

"Relative Merits of Discharging Batteries on Edison Systems through Reversible Boosters and Through End Cell Switches," Gerhard Goettling, Boston.

"The Use of Small Sized Carbons in A. C. Arc Lamps," G. N. Eastman, Chicago.

"Maintenance and Repair of Coal and Ash Handling Machinery," Chas. H. Parker, Boston.

"Practical Operation of the Nernst Lamp," W. T. Morrison, New York.

"Relative Advantages of 25 and 60 Cycles," Philip Torchio, New York; Wm. C. L. Eglin, Philadelphia.

According to President Fish, of the American Telephone & Telegraph Company, the Pupin coil is giving very satisfactory results, and will make possible the transaction of business by telephone between such points as Boston and Kansas City. It is found that by its use conversation can be carried on over long distances in all kinds of weather.

Aluminium for Transmission Lines

ALUMINIUM as an electric transmission line material is at a disadvantage when compared with copper in the matter of deflection from temperature variations where long spans are considered.

For example, according to H. W. Buck, of the Niagara Falls Power Company, supports for 400-foot spans of aluminium of 265,000 cm section will have to be 3.4 feet higher than the supports for equivalent copper. For spans of 300 feet or less, the matter of deflection is unimportant, for it makes little difference whether the deflection is 2 feet or 3 feet, more or less. But in very long spans where the difference may be 20 feet in the case of copper, and 30 feet in aluminium, the question of deflection is of considerable moment, and the advantages are in favour of copper. The height, therefore, of a support for a long-span line of aluminium would have to be greater than for a copper line.

Its strength, however, need not be so great as would be required for the support of a copper span. The weight of the aluminium wire is only 47 per cent. of the copper span of the same resistance, and, furthermore, the tension in the aluminium cables will be from one-half to one-third those of the copper ones, depending upon the temperature. Where there are bends in a line, and when each pole is designed to withstand unbalanced strains due to the breaking of one or more wires, the lesser weight and tension on the aluminium cables is a decided advantage which offsets, in a measure, the increased height required for the aluminium supports.

Another Automobile Exhibition

THE first automobile show held in this country was successfully promoted in November, 1900, by the Automobile Club of America, with the object of supporting and encouraging the then new sport and industry of motoring in America. Since that time the annual automobile show under the club's auspices has, from year to year, continued to increase in importance and magnitude.

Believing that the public interest in motor cars is now more wide-spread than ever before, the club for its sixth annual show in New York City has made liberal provision for an open exhibition of cars, parts and accessories of both home and foreign manufacture, and it invites manufacturers from all parts of the world, without restriction or qualification of membership in any organization, to exhibit their products.

The show will begin Saturday, January 13, and end Saturday, January 20, 1906, in the armory of the Sixty-Ninth Regiment, N. G. N. Y. This will be one of the finest exhibition halls of its kind in the world, and since it will be completed shortly before the date of the show, in itself it will prove an interesting attraction.

Fire-proof construction will mean a substantial saving to the exhibitors in insurance rates, and it will guarantee greater safety to the visiting public.

The special exhibits of the club, gathered from all over the world, will be an interesting feature of the show, and these will include cars used for military purposes, famous racing machines, and other vehicles demonstrating the varied fields of usefulness of the motor car.

London Metropolitan Railway Locomotives

THE first of the ten 150-ton electric locomotives being supplied to the London Metropolitan Railway by the British Westinghouse Company was delivered several weeks ago, and has recently been subjected to test under working conditions. A general view of one of the locomotives is given in the illustration on the opposite page.

The ten locomotives on order will be used for hauling the Great Western trains through the northern part of the circle between Edgware Road and Aldgate, for conveying the main line passenger traffic from Pinner, Rickmansworth, Verney Junction, etc., between Harrow and Baker street, and also for hauling freight trains.

Owing to the length of the trains and the cramped conditions existing at the termini it has been necessary to keep the length of the locomotives down to the lowest possible limit, and this has been effected by using motors of a smaller size than usual, equipped with forced ventilation. There are four motors, the normal ratings of which are 200 H. P. each; but by aid of the forced ventilation which is supplied by an air blowing set, the motors are capable of developing 250 H. P. each with safety.

Each locomotive is equipped with both the Westinghouse automatic air brake and vacuum brake, and each is coupled to the foundation brake gear in such a way that either may be manipulated and caused to apply the brakes without making any changes whatsoever in the connections.

These locomotives are able to haul a train weighing 170 tons, exclusive of the locomotive, at a maximum speed of 36 miles per hour, and a freight train of 250 tons, exclusive of locomotive, at a maximum speed of 27 miles per hour.

The motors are of the usual series-wound tramway type, and there is nothing novel in the winding. The air for ventilation is admitted to the motor at a pressure of 4 oz. per sq. in., and the mouth of the duct is so formed as to distribute the entering air over the entire end of the armature and field coils.

The cover of the motor is of the ventilated type, so that this air, after it has absorbed the heat from the armature and field coils, passes into the atmosphere.

The four motors are arranged in pairs. Each pair has a separate turret controller of the Westinghouse electro-pneumatic type. These controllers are manipulated by a single master switch and are not of the automatic type. The switches, however, are closed with the step-by-step method usual with tramway type controllers, this being necessary owing to the vast amount of shunting of goods and passenger trains in sidings.

The average weight on each wheel of the locomotive is 5 tons, 13 cwt. 2 qrs. The blower is fitted with a resistance which can be switched in shunt connection with the field coils, so that the speed may be increased 25 per cent, and the pressure of the air thereby increased from 4 oz. per sq. in. to 6 oz. per sq. in. This arrangement will be used when the motors are working under the most severe conditions of service.

According to the Manila "Daily Bulletin," electricity is rapidly being introduced in the various Phillipine towns for lighting and power, and many private and Government shops in Manila are importing direct-driven tools. Surveys have been made with a view to utilizing an excellent waterfall found in an adjoining province, transmitting its power electrically to Manila. Other water power abounds in the islands. The leading electrical houses in the United States are represented there by competent men, and it is safe to assume that this line of machinery will have extensive sale in the future. The recent change in the tariff, which imposes a duty of but 5 per cent. on this class of machinery, will stimulate its introduction.

THE FIRST OF THE TEN 150-TON ELECTRIC LOCOMOTIVES BUILT FOR THE LONDON METROPOLITAN RAILWAY BY THE BRITISH WESTINGHOUSE COMPANY

The Electric Motor in the Bakery

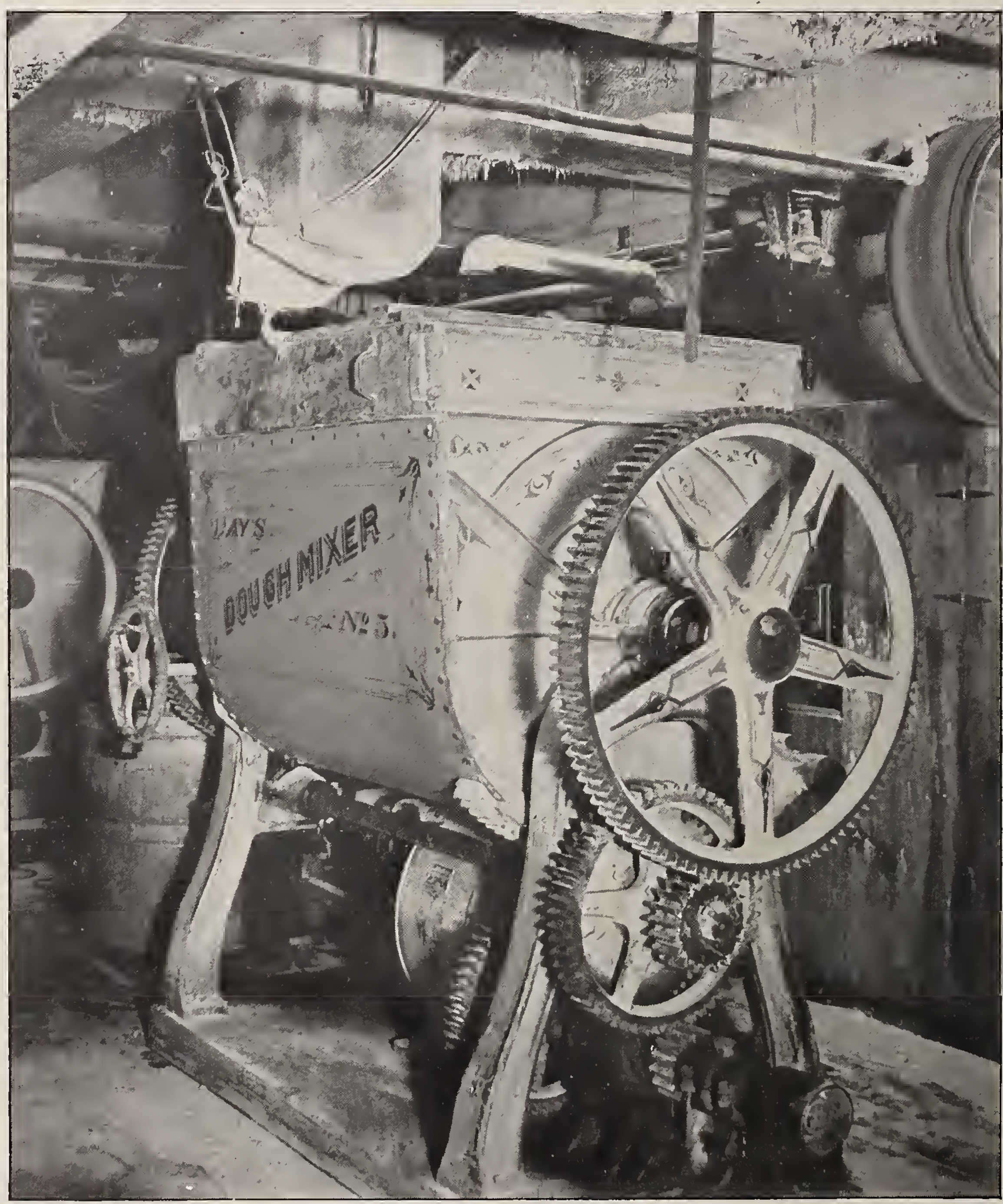
By H. S. KNOWLTON

ONE of the most interesting modern applications of the electric motor is found in the driving of bakers' machinery. The advantages shared in common by practically every industry using electric power for machine driving are conspicuous in the bakery which adopts motor-driven equipment, and in few commercial fields are the possibilities of detailed application more striking. A large part of the equipment of the present-day bakery is along the line of labour-saving appliances; manual work is constantly being eliminated and the cost of operation cut lower. It is emphatically worth while for the baker using the old-time steam engine and line-shaft drive to find out what the electric motor can do to improve his own particular operating conditions; it is desirable that the manufacturers of motors institute a broader educational campaign, showing by concrete examples what has been done in the way of reducing expenses or increasing output at a lower proportionate cost; and it is important that the central station man in search of a 24-hour load should not overlook the bakery field in his service expansion.

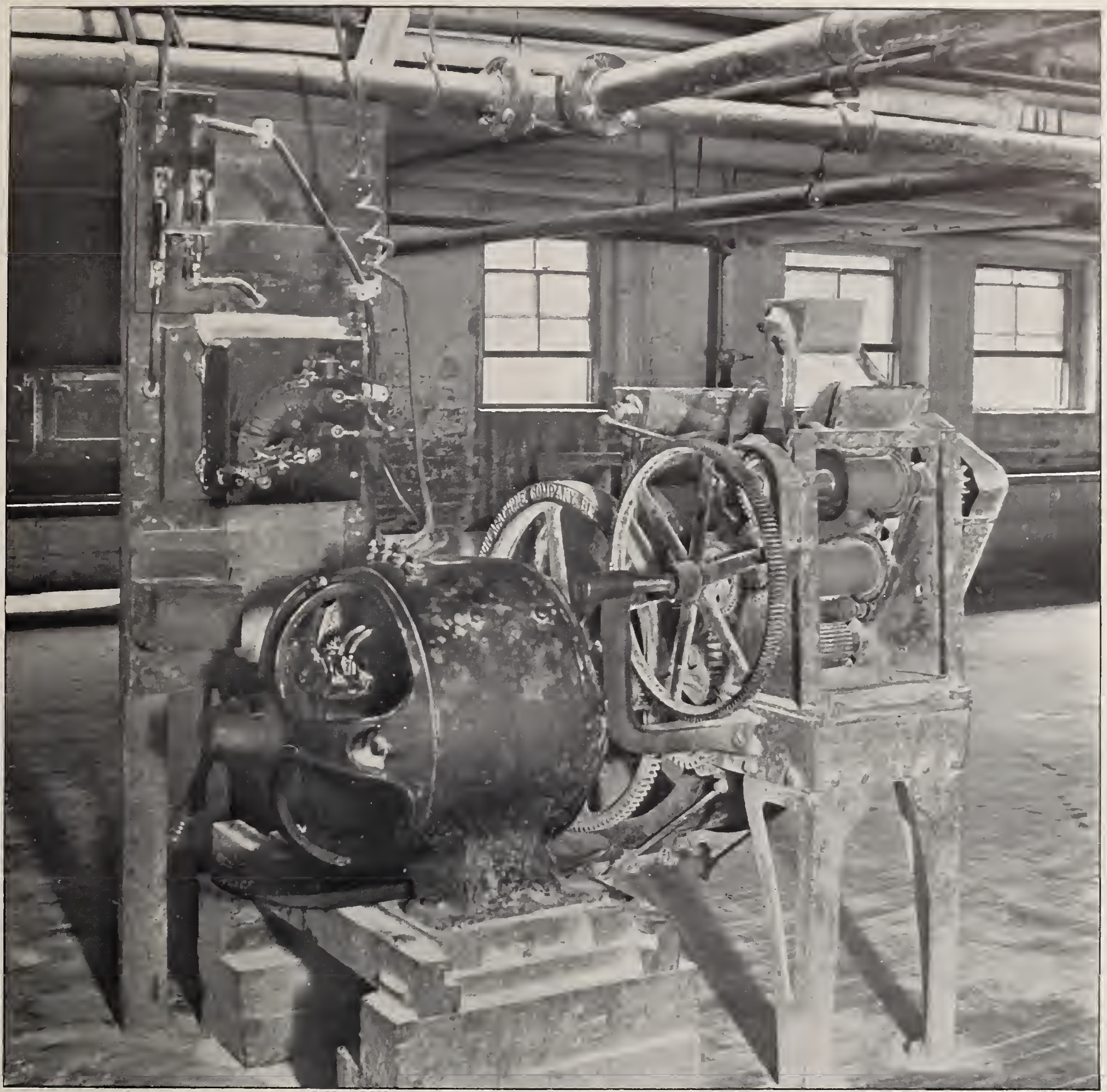
The cold storage of eggs at 12 degrees F., of milk, butter and lard at 40 degrees, and of pie "filling" at 32 degrees, requires an extensive refrigerating plant in a large bakery, and the ice-making machinery is open to the direct or belted motor-drive with the same efficiency and convenience found in other electrically operated cold-storage outfits. In the large bakery of Messrs. J. G. & B. S. Ferguson, at Boston, the equipment of which forms the basis of the following comments, a 12-ton-per-day ice machine is driven 168 hours per week by a 30-H. P., 110-volt motor. The electric elevator is useful in the bakery for handling barrels of flour, dough and other freight in large quantities, and there is scarcely a limit to the possible use of motor-driven fans in this line of work, where high temperatures are the rule and the odours from cooking ovens pervasive.

One of the most interesting machines in the bakery is the apple parer, capable of doing the work of 11 men. Such a machine will core and pare a barrel of apples in 12 minutes, and two of these outfits, driven by a 3-H. P. motor, will easily pare 60 barrels per 10-hour day in the busy season. As one man can pare but 3 barrels in 10 hours, the economy of the equipment is self-evident. Each machine needs but a single attendant, and the power cost is insignificant in comparison with the reduction in labour expense. Straining cloths are easily washed in a "75-shirt" laundry washer driven by a $3\frac{1}{2}$-H. P. motor, the work being done in 10 per cent. of the time required by the old hand methods.

Very large bakeries often maintain as many as 100 delivery wagons and 200 horses for distributing and advertising service. In the Ferguson plant the establishment is equipped with its own electrically lighted stable and blacksmith shop, besides a carpenter shop for woodwork repairs and box making. The blacksmith shop has three forges, the blower, drill, grindstone and saws being driven by a 10-H. P. motor, which also runs the carpenter shop planers



A MOTOR-DRIVEN DOUGH MIXER REPLACES THE UNCLEANLY HAND METHOD, MIXING FROM 10 TO 35 BARRELS OF FLOUR A WEEK AT A COST OF $2.00 A MONTH



THE BREAD-MOULDING MACHINE CUTS THE DOUGH INTO THE PROPER SHAPES OF LOAVES. IT IS DRIVEN BY A 30-H. P. GENERAL ELECTRIC MOTOR AND WILL TURN OUT 7000 LOAVES AN HOUR

and saws now used in the bakery.

The practice of driving rotary ovens by electric motors is growing in favour, and three ovens capable of baking 240 pies per hour can readily be operated by a 5-H. P. motor. In the Ferguson bakery the group system of driving is widely used, and on one of the upper floors a 7½-H. P. motor drives a squash machine, a brown-bread mixer holding 4 barrels of flour, an apple chopper, meat cutter, jelly press and pie-plate washing machine holding 4000 plates. The full loading of plates can be washed in 35 minutes, and one man working about 2 hours per day now does the work which formerly required 4 men's services. The flour-sifting and weighing plant is an important part of the equipment of a modern bakery, and the sifters, conveyors, elevators and flour-bag cleaners of the Ferguson installation are all driven by a 3½-H. P. motor.

One of the hardest tasks which the baker faces in turning out his product on a large scale is the mixing of dough. In the old days it was customary to perform this work by hand, kneading and rolling the dough by muscular effort and hand rollers. The difficulty of making every batch alike was no small matter, and the labour cost was excessive, to say nothing of the physical wear and tear sustained by the employees. The electric motor has been applied to dough-mixing machinery with the greatest success, and in all up-to-date plants hand labour has been almost entirely eliminated from the mixing process. A dough-mixing machine designed for a shop baking from 10 to 35 barrels of flour per week can be installed complete with direct-connected motor for about $460, the cost of operation being but

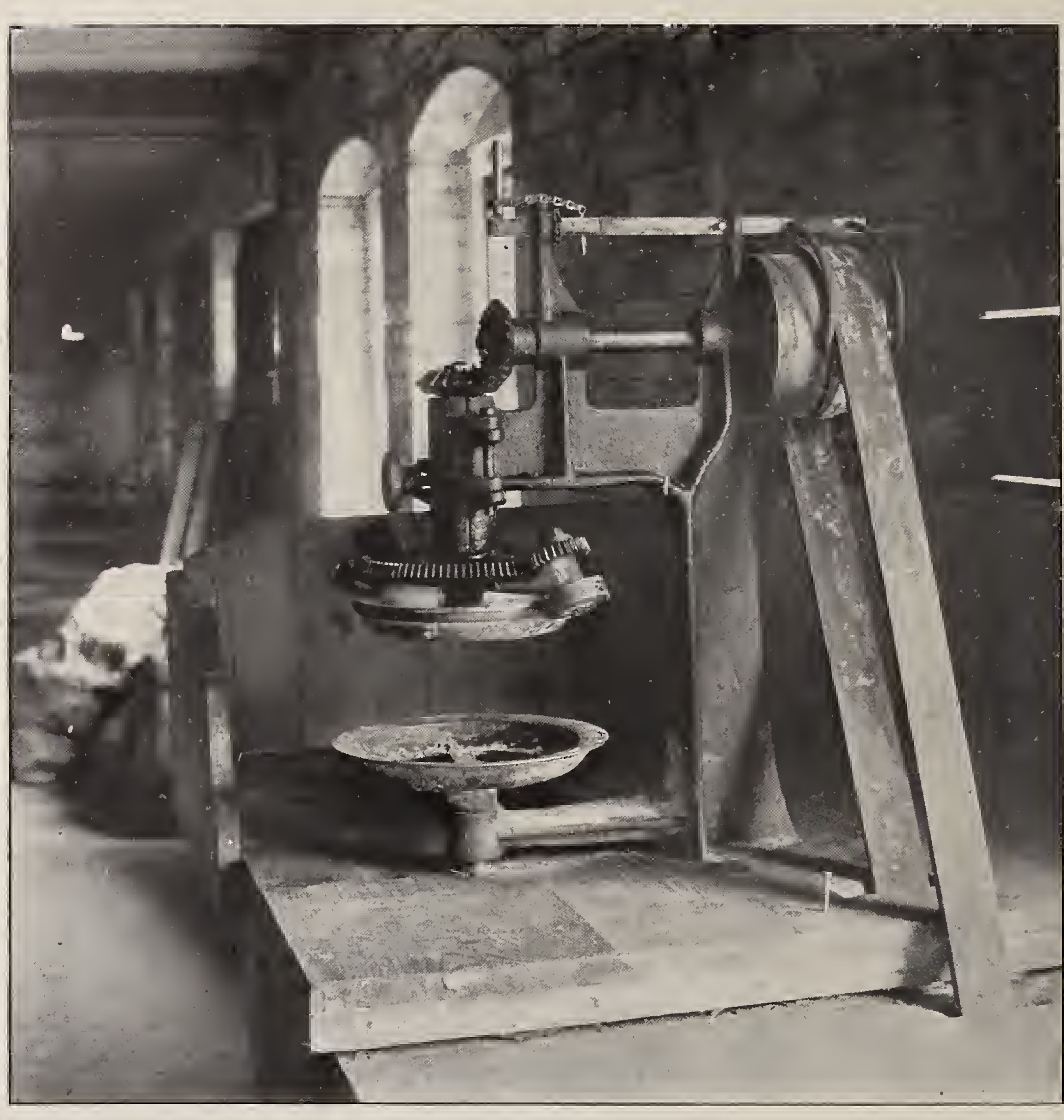
$2 per month. The service requires a substantial motor, as the center of gravity of the mass of dough constantly shifts, and the mixer is a hard-running machine on account of the work it does. One of the mixers in the Ferguson plant is gear-driven by a 20-H. P., 110-volt motor. It has a capacity of 6 barrels, and will mix such a batch in 45 minutes.

Two other mixers and a flour machine are also installed in this bakery, a 30-H. P. motor supplying the driving power. Another interesting piece of apparatus is the bread-moulding machine, driven by a 10-H. P. motor, direct connected. This machine cuts the dough into the proper shapes of loaves of bread and will turn out 7000 loaves per hour when in full operation. Another important machine is the so-called "scaling" machine, driven by a 2½-H. P. motor. Its function is to weigh out the amounts of dough needed for various sized loaves, according to the setting of a scale ranging from about 15 to 32 ounces. Four lumps of dough are delivered at a time, the capacity of the machine being 3000 pieces per hour. There is also a "setting up" machine for pinching up the rims of custard and squash pies. It has a capacity of about 3000 pies per hour and is driven by a 2-H. P. motor. Four cake machines for mixing frosting and dough are group driven by a 10-H. P. motor; another 10-H. P. motor drives a sugar-pulverizing machine having a grinding capacity of 1000 pounds per hour.

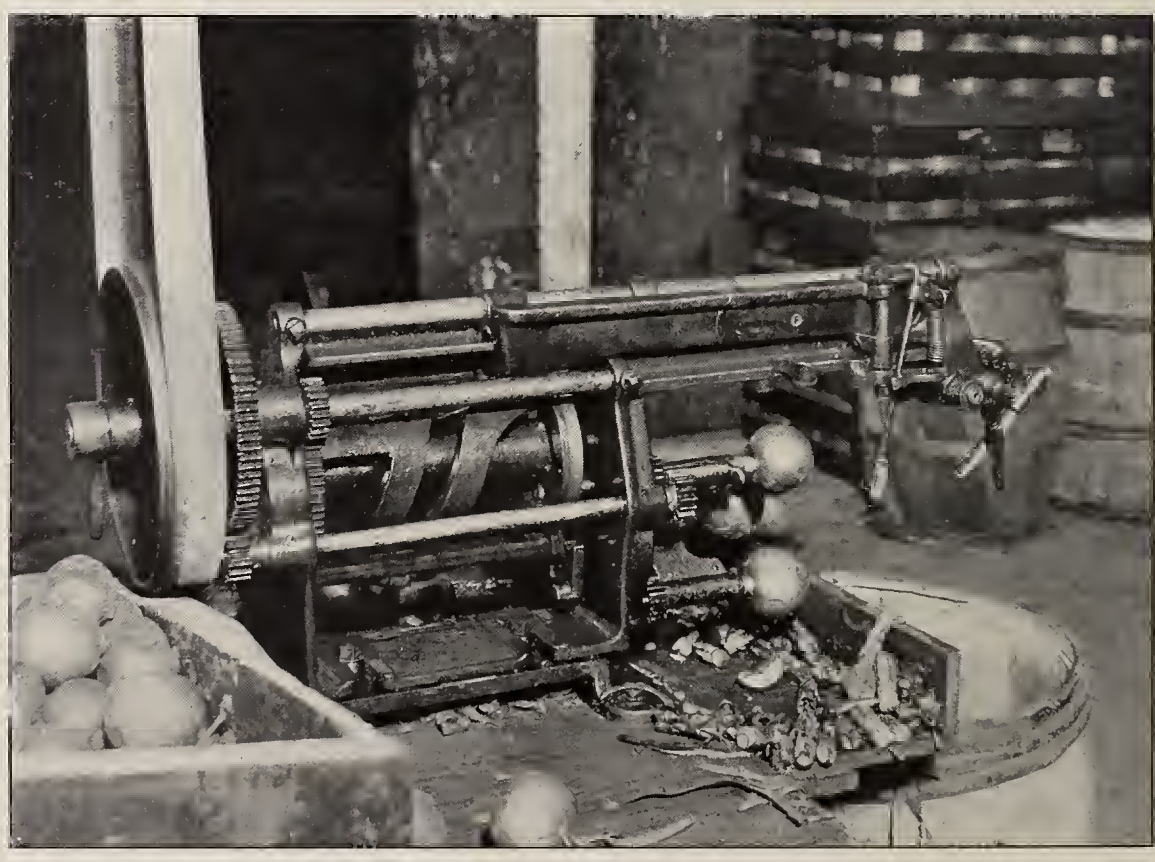
Incandescent lamps are used throughout the bakery and an auxiliary fire alarm system is installed. For lighting, each oven is equipped with a 16-candle-power lamp mounted in an iron box set into the brick work in front of an aperture which transmits the light into the interior. A mica door protects the lamp from the direct heat of the oven.

In many bakeries the manufacture of ice cream constitutes an important part of the business, and the electrically driven freezer has been found to be extremely economical. A 9-gallon freezer driven by a ½-H. P. motor costs, complete, about $200, and such a machine will freeze its full capacity of cream in about 18 minutes with a power consumption of 173 watt-hours. At 10 cents per kilowatt-hour, the cost of freezing a gallon of cream figures about one-fifth of a cent. Compared with hand labour the cost is insignificant, and the increased output possible with the motor-driven machine is of great commercial value.

For first-class bakery work, clean premises are a prime requisite, and the motor drive supplies this throughout an establishment. The power is directly applied, giving the highest efficiency of operation; machines may be shut down without the necessity



PINCHING UP THE RIMS OF CUSTARD AND SQUASH PIES IS ALSO DONE BY A MACHINE BELTED TO A 2-H. P. WESTINGHOUSE MOTOR. IT HAS A CAPACITY OF 3000 PIES AN HOUR



THE APPLE PARER DOES THE WORK OF ELEVEN MEN. A BARREL OF APPLES IS PARED AND CORED IN TWELVE MINUTES BY ONE MACHINE, AND TWO MACHINES, DRIVEN BY A 3-H. P. GENERAL ELECTRIC MOTOR, WILL PARE SIXTY BARRELS IN A TEN-HOUR DAY

THE SCALING MACHINE IS DRIVEN BY A 2½-H. P. WESTINGHOUSE MOTOR, AND WEIGHS OUT THE DOUGH FOR VARIOUS SIZED LOAVES, ACCORDING TO THE SETTING OF A SCALE RANGING FROM 15 TO 32 OUNCES

of keeping shafts and belts in operation; a break-down in one department stops the machines of few, if any, others; noisy, dirty and troublesome shafting is reduced in amount, and repairs and maintenance are reduced to a minimum, as is also the space required. Although the direct-current motor is largely used at present in bakery work, there would seem to be little reason why the induction motor could not be more generally applied, with its ability to stand hard usage and to require no attention on account of commutator and brushes.

It is also reasonable to expect individually driven bakery machines to come into wider use, so that the amount of belting and shafting used at present may be still further reduced. A good start has already been made in this direction, and as electric motor designers seem to be capable of producing machines to meet practically every commercial condition, there is little doubt that later installations will swing more and more into the line of separately driven units.

Electric heaters have thus far made little headway in the commercial bakery, but for cooking waffles and griddle cakes in bakeries where restaurants are attached a field for special heaters exists.

The International Association of Municipal Electricians

Tenth Annual Convention

THE tenth annual convention of the International Association of Municipal Electricians was held at Erie, Pa., on August 22, 23 and 24, in the banquet hall of the Reed House.

The president, Walter M. Petty, called the meeting to order at 10 a. m., and after a prayer by the Rev. A. C. Ellis, Mayor R. J. Saltsman welcomed the association to the city. J. B. Yeakle, of Baltimore, responded on behalf of the association.

The president then made an address, taking for his subject, "Suggestions as to Means of Increasing Our Membership and Adding to Its Value." Among other things he said, "Our name would be a misnomer if we did not include in our membership all the various branches of municipal electrical engineering. In so doing we should so arrange our conventions as to make them of value to all. This can best be accomplished by a division into sections, somewhat after the manner of the congress held at St. Louis last year.

"In the election of officers, the members of the executive committee should be selected so as to represent each branch."

In the afternoon session the first paper read and discussed was by Capt. William Brophy, of Boston, Mass., on "Suggested Improvements in Fire-Alarm Telegraph Systems." In the absence of the author, the paper was read by Mr. Yeakle. It provoked considerable discussion, not all the members agreeing with the ideas expressed.

The second paper, entitled "Advisability or Inadvisability of Fusing Fire and Police Telegraph Boxes," was read by the author, C. E. Diehl, of Harrisburg, Pa. His conclusion that it was not advisable to fuse such boxes was in accord with the opinion of almost all his hearers.

A paper by Louis Gascoigne, of Detroit, on "Underground Construction," followed. The author referred to various ways of constructing conduits, and spoke of their good and bad qualities. The paper was freely discussed, the meeting then adjourning for the day.

The morning session of Wednesday was called promptly to order at 9:30, and a paper on "Erection and Maintenance of Electric Light Plants" was read by C. L. Williams, of Laurie, Miss. Following this, A. S. Hatch, of Detroit, presented a paper on "Electric Light Engineering." The next paper, "Need of a Rigid Inspection by the Municipality," was read at the afternoon session by the author, T. C. O'Hearn, of Cambridge, Mass. In the discussion following, a majority of the members participated, all agreeing with Mr. O'Hearn that the municipalities should inspect all wires. H. R. Allensworth, of Columbus, Ohio, then presented a paper on "The Effects of Electrostatic Influence on Telephone and Telegraph Circuits," and after the discussion the convention adjourned for the day.

The question box opened the morning session on Thursday, and the meeting then took up general business and reports. The election for officers resulted as follows:— President, Jerry Murphy, of Cleveland, Ohio; vice-presidents, Wm. Crane, H. R. Allinsworth, B. A. Blakey, and F. A. Cambridge; sec-

retary, F. P. Foster, of Corning, N. Y.; treasurer, C. E. Diehl, of Harrisburg, Pa.; executive committee, T. C. O'Hearn, of Cambridge, Mass.; A. S. Hatch, of Detroit, Mich.; J. B. Yeakle, of Baltimore, Md.; Louis Gascoigne, of Detroit, Mich.; W. M. Petty, of Rutherford, N. J.; James Grant, of New Haven, Conn.; W. H. Thompson, of Richmond, Va., and W. Y. Ellett, of Elmira, N. Y.; finance committee, W. D. Clayborne, J. T. Macdonald, and H. C. Bundy.

New Haven, Conn., was selected as the place for the convention next year.

An Electrical Trades Exhibition in New York

AN electrical trades exhibition is to be held at Madison Square Garden, in New York, from December 12 to 23.

There has not been an electrical exhibit in New York City since 1899, and on account of the many developments that have taken place, both in the construction and development of electrical appliances, it is felt that this show will provide an excellent opportunity for demonstrating to the trade as well as to the general public, the advances in the different lines of applied electricity.

The construction of dynamos and motors of various types, the progress in telephony and telegraphy, motor speed control and its use in machine-tool driving, and the various types of power transmission engineering, will be shown. This will give an excellent opportunity to make prospective buyers acquainted with the advantages of the different types of apparatus. Exhibit space will be sold, and selling privileges for electrical novelties and other specialties will be disposed of.

Direct current at 115 volts, and 2-phase, 60-cycle alternating current at 104 volts will be available. Gas can be secured, and steam will be available to a limited extent. Power will be charged for at the rates which have been fixed by the management. Applicants for space should state the number of square feet required for a creditable presentation of their display, and should mark upon the official diagram, which will be sent upon request, the spaces preferred, numbered in the order of their choice.

About 70 per cent. of the copper output of the world is refined electrolytically. From the 250,000 tons treated in the United States, 27,000,000 ounces of silver and 364,000 ounces of gold are recovered.

Change of Control of the Niagara, Lockport & Ontario Power Company

THE Niagara, Lockport & Ontario Power Company recently passed under the control of a syndicate headed by George Westinghouse and John J. Albright, of Buffalo. It is reported that New York Central Railroad and Vanderbilt interests are also represented, with those of Horace E. Andrews, of Cleveland, and others. The officers are:—General Francis V. Greene, president; F. B. H. Paine, formerly export manager of the Westinghouse Electric & Manufacturing Company, vice-president and chief engineer; Robert C. Board, secretary; and Clifford Hubbell, treasurer. The offices of the company have been moved to the Fidelity Building, Buffalo. S. M. Clement, president of the Marine National Bank, of Buffalo, succeeds Mr. Robin on the board of syndicate managers for the underwriting of the company's securities.

The company has made a long-term agreement with the New York Central Railroad Company for the supply of electric power, and contracts have also been signed with local trolley lines. Nearly all the lines in Syracuse will possibly be operated by Niagara power in the spring of 1906.

The Control of Electric Railways by Steam Roads

IN the form of a round number and in "net" shape the New York, New Haven & Hartford has given out the receipts for the fiscal year ending June 30, of the great electric system owned or controlled by the Consolidated Railway Company as a holding corporation. The showing is remarkable, says "The Railroad Gazette," and goes far, as a precedent on a very large and extended scale, to justify the theory of the purchase of electric railways by steam roads.

The "net" returned over and above all operating expenses and fixed charges is \$426,000, or about 4¼ per cent., on the Consolidated Railway Company's stock capital, which is all owned by the parent steam corporation. From this, however, is to be deducted approximately \$350,000 of interest on the issue of about \$10,000,000 of debentures of the steam corporation—a direct obligation used for the purchase of the Fair Haven & Westville system. Subtracting that amount it leaves \$76,000 as the net profit of the first year's operation of the Consolidated Railway system—though it is likely that, in the case of some of the street railway lines acquired during the year, figures are included which do not fall into the period during which the holding corporation has been operating those lines.

Stated in somewhat different words, during the first year of its great electric ventures the New Haven Company seems not merely to have made good its investment, but earned \$76,000 besides—and to the \$76,000 should be added about \$80,000 a year, which were being, in past years, lost annually on the Worcester & Connecticut Eastern system and which are now "digested" in the general financial returns of the Consolidated Railway Company.

Wireless Telegraph Installations in Alaska

THE United States Government is preparing to install the wireless telegraph system throughout the Lower Yukon country, replacing land lines that have proved failures to a large extent. The greatest difficulties have been encountered in maintaining the land system in the face of forest fires, floods, cold weather, and other obstacles. Capt. Wildman, the Government wireless expert, is now on the Yukon experimenting with the system between Fort Gibbon, at the mouth of the Tanana River, and Nome. He was in constant communication with St. Michael's on the trip up the river to Fort Gibbon. St. Michael's in turn was connected with Nome.

Lightning and Concrete Steel Buildings

THE necessity for lightning protection of concrete-steel buildings, according to "Beton und Eisen," does not hold as with those of ordinary construction. The lightning discharge will be carried away by the rods, girders and wire mesh in the roof and then, greatly reduced in intensity, flow down to the ground through the columns and foundations.

Three telautograph instruments have been in use experimentally at the Union Station, in Pittsburg, for some months past as a means of communication between the station master and outlying trainmasters' offices. It is now stated that these instruments will be utilized regularly for reporting trains locally in and out of the station.

THE ELECTRICAL AGE

Established 1883

Volume XXXV Number 4
$2.50 a year; 25 cents a copy

New York, October, 1905

The Electrical Age Co.
New York and London

Recent Applications of Electric Motors to Machine Tools

By GEORGE W. MARTIN

FIG. 1.—A MOTOR-DRIVEN BREAST DRILL MADE BY THE SPRAGUE ELECTRIC COMPANY, NEW YORK

So many special considerations enter into the question of power transmission for a manufacturing plant, that no general rule can be given to fit every case. In the matter of efficiency of transmission, an advantage, often cited, of the electric drive over the belt drive from line shafting, is that with the latter fully 50 per cent. of the power generated is lost in the shafting.

There are other considerations, however, which directly affect the labour cost and thus become relatively more prominent, as the cost of power varies from 2 to 5 per cent. only of the cost of production, while that of labour amounts to about 50 per cent. These latter considerations may be summarized as follows:—

Reliability of the service; the extent to which an accident to any part will affect the whole system; its effect in determining the structure of the building; light, ventilation, cleanliness, and the safety of workmen; the satisfactory handling of raw and finished material to and from machines; its effect on the quality of the product; facilities for extension; the possibility of using portable tools; freedom in the location of tools.

Having decided on electricity as a motive power, it remains to choose between a direct-current or an alternating-current system. The choice will depend largely on the character of the work. In cotton mills, for example, constant-speed motors are ordinarily used, as the work requires uniformity in speed, such speed changes as are necessary being infrequent and, therefore, obtained by mechanical devices. On the other hand, machine-shop work requires

FIG. 2.—AN INTERPOLE VARIABLE-SPEED MOTOR, BUILT BY THE ELECTRO-DYNAMIC COMPANY, BAYONNE, N. J. THE AUXILIARY POLES BETWEEN THE MAIN POLE PIECES ARE CLEARLY SHOWN

frequent and easy speed changes and exact speed control. For the cotton mills, therefore, an alternating-current system with induction motors is eminently fitted, while for machine-tool driving, a direct-current, variable-speed motor is most widely used. In some cases, however, the simplicity of the induction motor and its ability to stand a good deal of abuse have caused its adoption for variable-speed work. It is then used with mechanical speed-changing devices, or the variable speeds may be obtained by inserting resistance in the secondary circuits, the controller also permitting reversal by interchanging the leads in the primary. Single-phase series and repulsion motors are also coming into use for variable-speed work.

In the direct-current system, a shunt-wound motor is used, speed variation of the motor armature being obtained by varying the field strength while the armature potential remains constant; by varying the armature voltage while the field remains constant; and by changing the number of conductors in series on the armature.

The first method is open to the objection that, at the higher speeds, serious sparking at the brushes results. Special types of motors have been designed to overcome this difficulty. One of these, built by the Electro-Dynamic Company, of Bayonne, N. J., is shown in Fig. 2. In this motor, the variation of field strength is obtained by varying the current through the field windings by means of a rheostat. At the higher speeds, the weakened field is not strong enough to cause the coils short-circuited under the brushes to generate an electromotive force sufficient to overcome the electromotive force of self-induction. Accordingly, auxiliary pole pieces are placed between the main pole pieces with their windings in series with the armature, thus producing the required compensatory field of commutation independently of the main field.

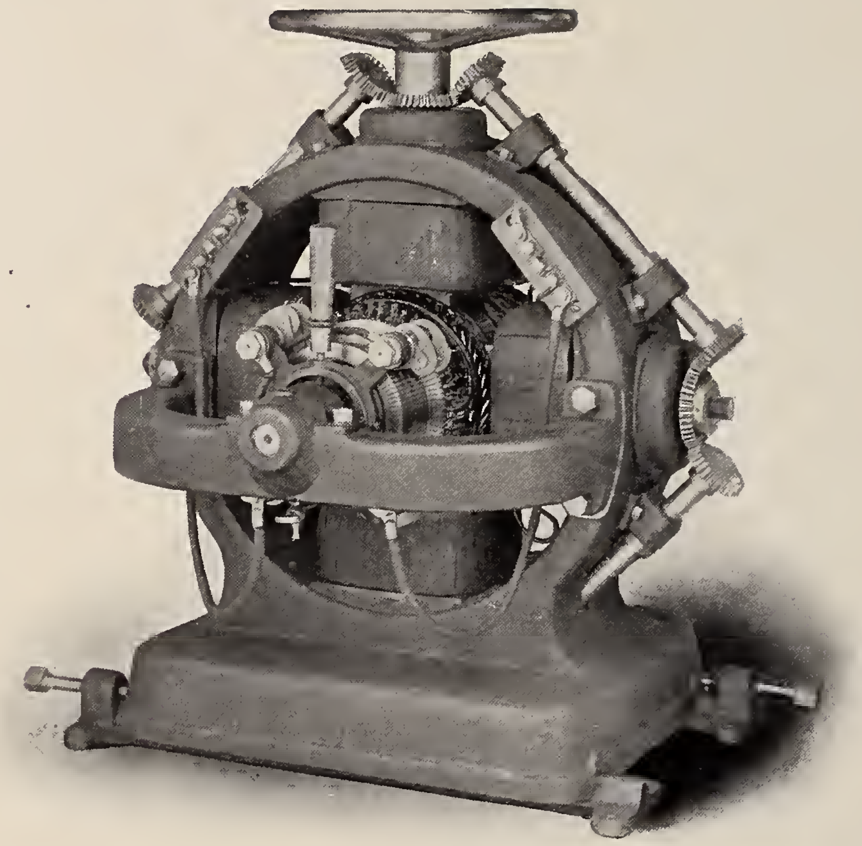


FIG. 4.—A MULTI-SPEED MOTOR MADE BY THE STOW MANUFACTURING COMPANY, BINGHAMTON, N. Y. THE HAND-WHEEL, SHAFTS AND BEVEL GEARS SHOWN SERVE IN MAKING THE INTERNAL SPEED-VARYING CHANGES

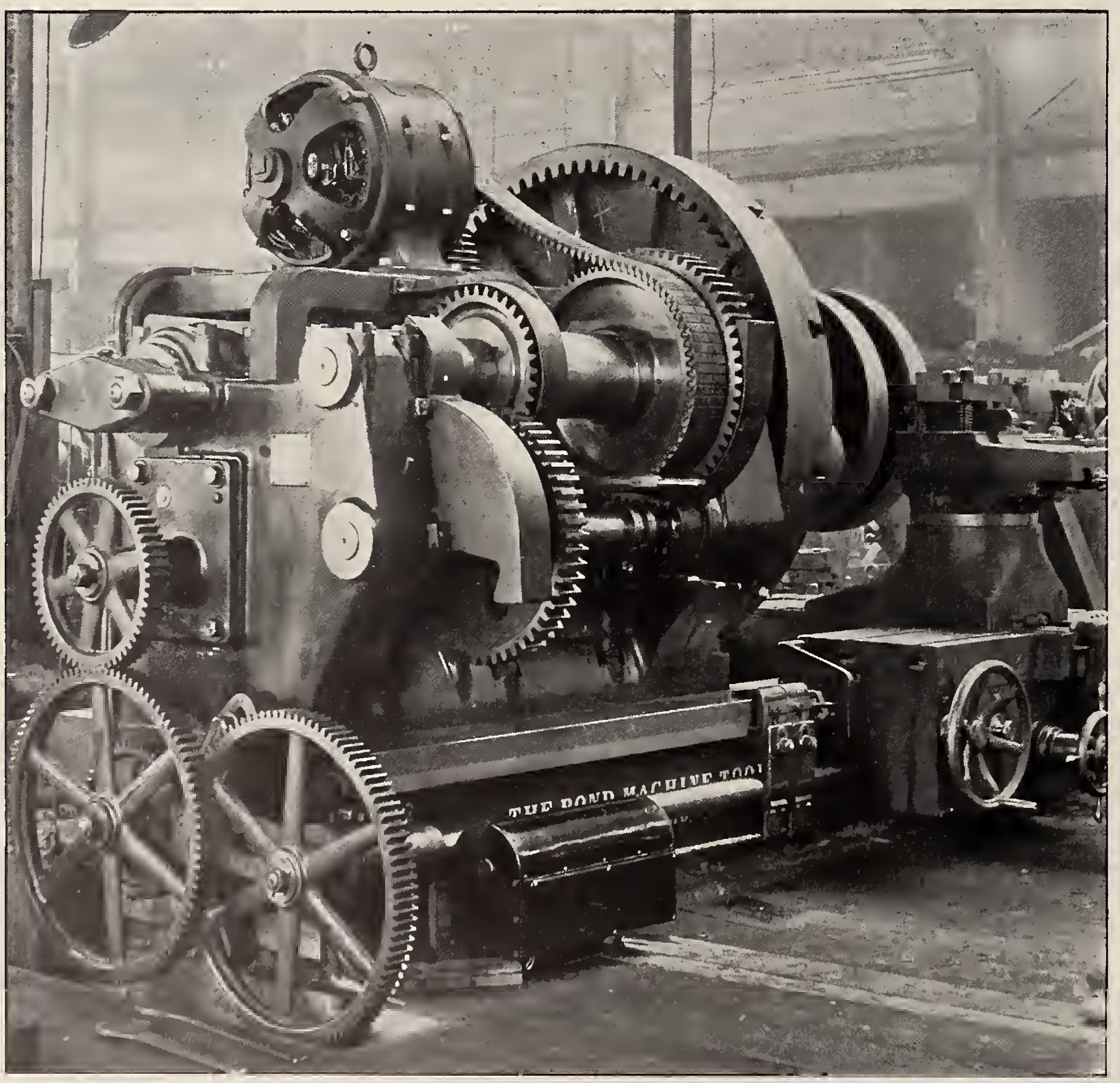


FIG. 3.—A VARIABLE-SPEED MOTOR WITH SHUNT AND SERIES FIELD COILS, BUILT BY THE RIDGWAY DYNAMO & ENGINE COMPANY, RIDGWAY, PA.

Fig. 3 illustrates another variable-speed motor in which the variation of speed is obtained by weakening the field. This motor is built by the Ridgway Dynamo & Engine Company, of Ridgway, Pa., and is provided with auxiliary balancing coils for maintaining the commutation field. The coils are independent of the shunt fields and are connected in series with the armature.

Another method of varying the field strength is by varying the reluctance of the magnetic circuit. Fig. 4 shows a variable-speed motor built by the Stow Manufacturing Company, of Binghamton, N. Y., in which this is accomplished by using hollow pole pieces provided with a large iron core or plunger, adjustable by means of a screw, attached to the plunger, and a hand wheel. By withdrawing the plunger, the ob-

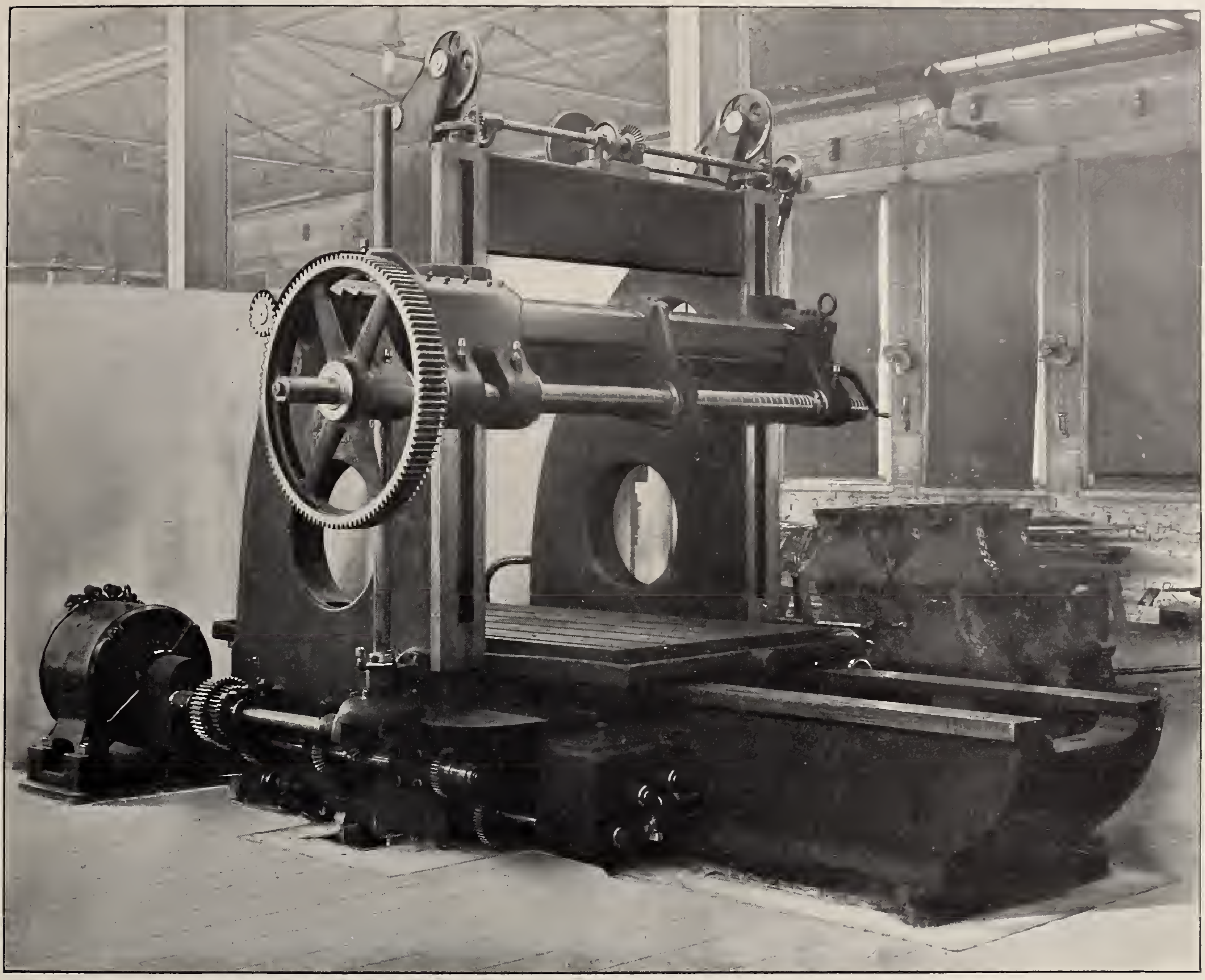


FIG. 5.—A MOTOR BUILT AT THE BULLOCK SHOPS, AT CINCINNATI, OF THE ALLIS-CHALMERS COMPANY, OPERATING ON THE THREE-WIRE, THREE-VOLTAGE SYSTEM, DRIVING A HORIZONTAL MILLING MACHINE BUILT BY THE INGERSOLL MILLING MACHINE CO., ROCKFORD, ILL.

ject is to cause the air column within the pole piece to offer a gradually increasing barrier to the cross-magnetizing effect of the armature.

When the field is reduced to a minimum by fully withdrawing the plunger, the armature reaction is also reduced from lack of a conducting path through which to act. It is also sought by this movement to force the remaining magnetic flux more and more to the pole tips, thus furnishing a magnetic field of sufficient intensity to insure sparkless commutation.

For changing the speed of a shunt-wound motor by varying the voltage impressed on the armature, rheostatic control is the simplest method of changing the voltage, though it has the disadvantage of wasting energy and causing a change in speed with any change in the load, due to the percentage drop in the rheostat changing with the load. It is sometimes used, however, in driving reciprocating machine tools, since, on the cutting stroke, the acceleration in speed of the tool is balanced by the drop in speed of the motor, and on the return stroke, the motor speeds up, thus reducing the time occupied in this part of the operation.

The most satisfactory way of obtaining variable speed by varying the voltage impressed on the armature, is by employing two or more supply circuits, intermediate variation being obtained by field control. About the simplest system is that using three wires, such as are ordinarily used in the three-wire lighting system, the voltage across the outside being double that between each outside wire and the middle one.

The motor field is connected across the outside wires and the armature is also connected across these, or an outside wire and the middle one. Two primary speeds are thus obtained, the finer gradations coming from variation of the field strength. In the controller for making the various speed changes, a field rheostat is used, the first position of the handle connecting the armature across an outside wire and the middle one, with no resistance in the field circuit. The motor then runs at its lowest speed; weakening the field by introducing the resistance causes the motor speed to increase.

The next position of the controller handle cuts out all the field resistance and at the same time connects the armature across the outside wires. The speed is next again increased by introducing resistance in the field, the highest speed being that with all the resistance cut in.

A three-wire system giving three voltages, however, may be had by using what is termed a "balancer."

FIG. 6.—A ROW OF PLANERS IN THE SHOPS OF THE WEIR FROG COMPANY, AT EAST NORWOOD, OHIO, DRIVEN BY COMPOUND-WOUND BULLOCK MOTORS BUILT BY THE ALLIS-CHALMERS COMPANY, OF MILWAUKEE, WIS. ON MOST OF THESE PLANERS THE MOTOR IS MOUNTED ON A BRACKET ATTACHED TO THE HOUSINGS, AND THE MOTOR SHAFT IS COUPLED TO A COUNTER SHAFT

In the three-wire system of the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, the balancer consists of two comparatively small machines mounted on the same base and coupled together. The armatures are connected in series across the outside 250-volt circuit. The armature of one machine is wound for 90 volts and that of the other for 160 volts, the fields of both being connected across the 250-volt circuit. The controller is arranged to introduce resistance into the field circuit, thus giving twelve speeds in the forward direction and nine in the reverse. Figs. 5 and 8, among others, show Bullock motors on the three-wire, three-voltage system. With either of the systems just mentioned, specially designed motors must be used, in order to permit satisfactory commutation under considerable changes in field strength.

A more elaborate method, and one permitting a wider range of speed, is that in which four wires and six voltages are used, necessitating a three-machine balancer. As in the three-wire system, the motor field is connected permanently across one of the circuits. Here also intermediate variations of speed are obtained by field control, with the use of a specially designed motor. Standard constant-speed motors, without field control, may be used, however, though the speed changes in jumps and the number of changes is limited.

Two other types of variable-speed motors are similar, in that both have two sets of windings and two commutators. In the one, the armature windings may be placed in series or parallel, and in the other the windings differ in the number of turns, and may be connected in series, acting together or opposing each other.

In some cases all the speed changes are not obtained with a variable-speed motor, a mechanical speed variation doing supplementary work in this respect. Fig. 14 illustrates a 90-inch driving-wheel lathe, built by the Niles-Bement-Pond Company, of New York, and driven by a motor built by the Northern Electrical Manufacturing Company, of Madison, Wis. Here a speed variation of 2 to 1 is obtained by the motor, changes by gearing giving a wider range.

Fig. 10 illustrates another example of a variable-speed motor used with mechanical speed control. The tool is a vertical milling machine built by the Newton Machine Tool Works, of Philadelphia. A speed variation of 2 to 1 is obtained with the motor, and this is increased to 4 to 1 by means of back gears.

FIG. 7.—A BENDING ROLL BUILT BY THE CINCINNATI PUNCH & SHEAR COMPANY, CINCINNATI, OHIO, DRIVEN BY A 15-HP. WESTINGHOUSE INDUCTION MOTOR WITH AUTO-STARTER AND DRUM FOR REVERSING

As previously stated, the induction motor is also being used in connection with speed-changing gears for variable-speed work. Fig. 13 shows the head of a lathe similar to that in Fig. 14, equipped with an induction motor built by the General Electric Company, of Schenectady, N. Y. The difference between the two types of drive may be readily noted.

Figs. 7 and 12 also show the induction motor applied to machine-tool work, although in these cases no variation of speed is required. The motor shown in Fig. 7 is provided with an auto-starter and a reversing drum, while that in Fig. 12 has a starting box only.

Fig. 11 shows a single-phase induction, repulsion motor, built by

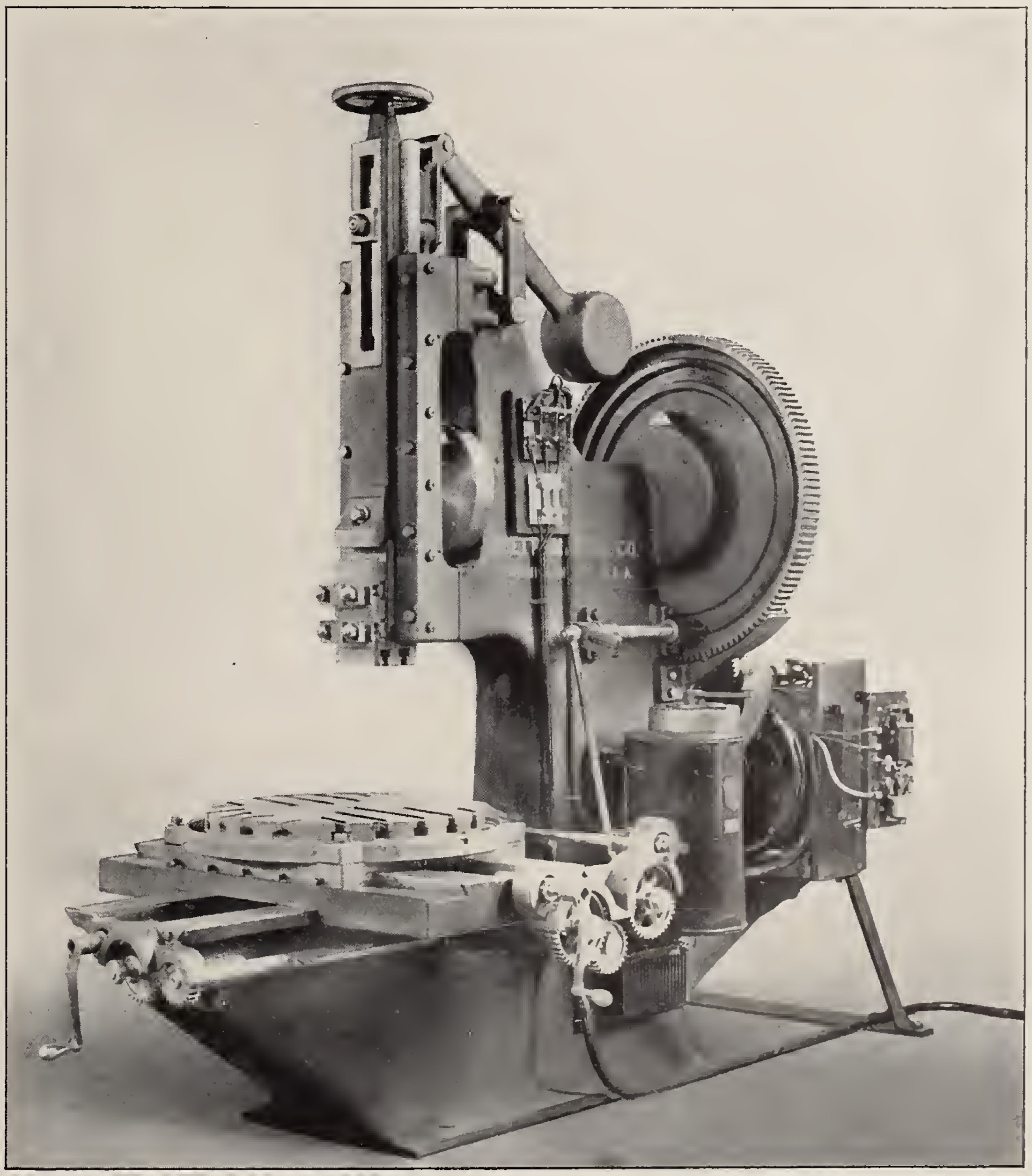


FIG. 8.—A BULLOCK MOTOR OPERATING ON THE THREE-WIRE, THREE-VOLTAGE SYSTEM, DRIVING A SLOTTING MACHINE BUILT BY THE BETTS MACHINE COMPANY, WILMINGTON, DEL.

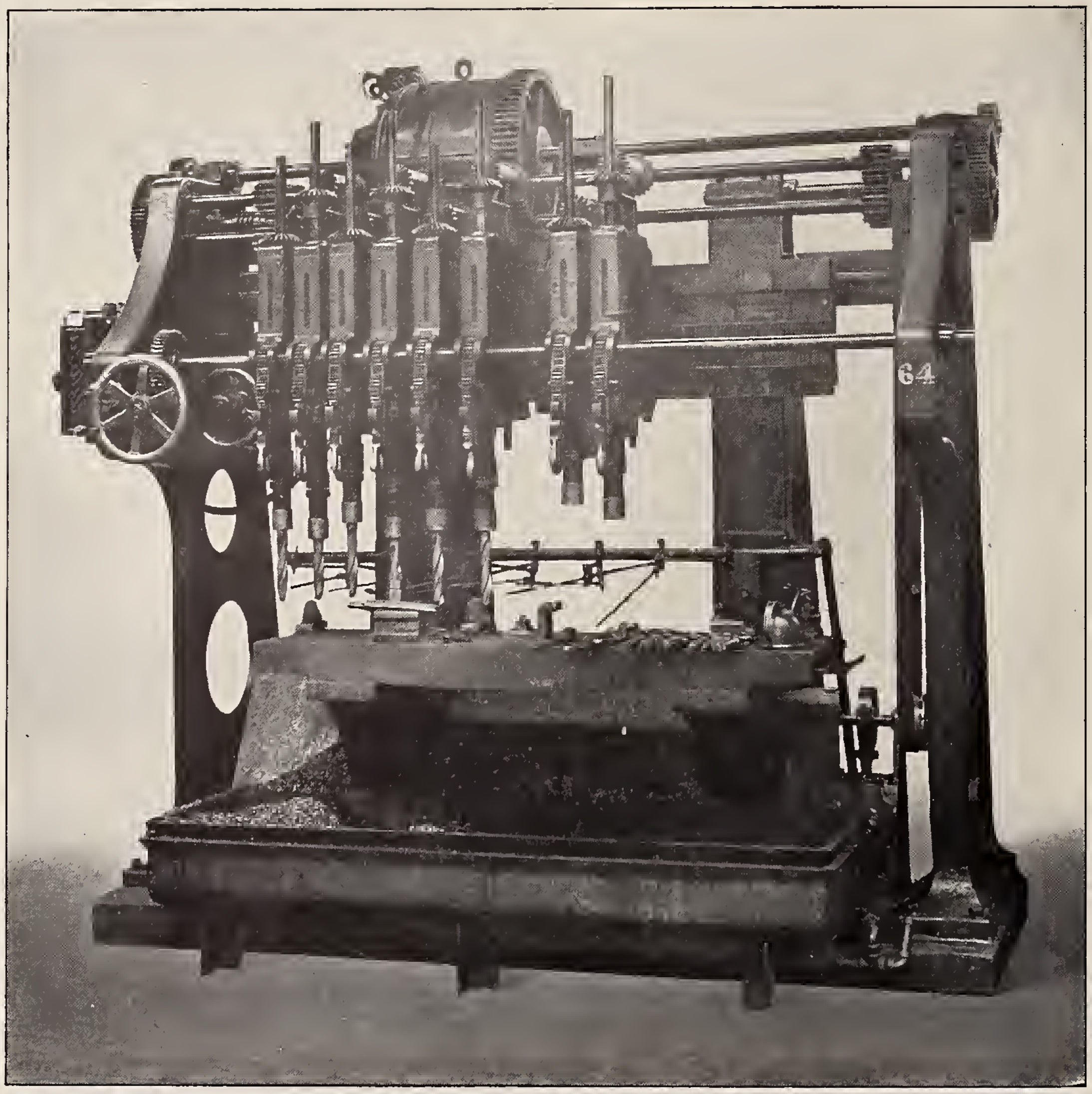


FIG. 9.—A MULTIPLE-SPINDLE DRILL PRESS OPERATED BY A BULLOCK MOTOR MOUNTED ON A BRACKET ATTACHED TO THE HOUSINGS

the Wagner Electric Manufacturing Company, of St. Louis, Mo., driving a vertical boring and turning mill built by the Gisholt Machine Company, of Madison, Wis. The field of the motor is laminated and the armature is of the direct-current drum type. Inside the armature are two governor weights, which are thrown outward by centrifugal force when the machine reaches full speed, short-circuiting the armature winding and lifting the brushes off the commutator. The motor thus is self-starting as a repulsion motor and later runs as an induction motor. Speed variation of the tool is obtained by means of two silent chains, shown in the illustration, with the casing removed, a clutch, operated by a lever, engaging either driven gear.

In the driving of planers by electric motors, the armature shaft is usually direct connected to the forward and reversing pulleys. This arrangement would place a strain on the motor at the moment of reversal were not the reversing pulley made heavy enough to act as a fly-wheel, storing enough energy on the forward stroke to carry over the point of reversal. In Fig. 16 it will be noticed that the reversing pulley has an unusually heavy rim for this purpose. In those cases where one motor drives a group of planers, a long overhead countershaft is used with heavy pulleys. Ordinarily, two planers will not reverse at the same instant, so that a smaller motor may be used.

Fig. 17 shows a motor-drive for planers which allows a variation in the cutting speeds of the table, the speed of return remaining constant. A variable-speed motor is used, and is connected through a countershaft to the driving mechanism by a series of clutches and gears.

Fig. 19 illustrates a planer drive in which a system of control designed by the Electric Controller & Supply Company, of Cleveland, Ohio, is used in connection with a Westinghouse variable-speed, reversing, compound-wound motor. The latter is connected to the cross-shaft of the tool and is reversed at the end of each stroke by a reversing switch and the dogs on the platen. To make this operation successful, an automatic controller gradually accelerates the motion of the platen after reversal and limits the amount of current to the motor, so that there is no sparking or danger of injuring the motor. During the cutting stroke, the platen is thus accelerated to a speed determined by an operating controller, the return stroke being always at the same speed.

A class of machine tools, the development of which the electric motor has greatly aided, are those of the portable type, varying in weight and size between wide limits. The most common of the small portable

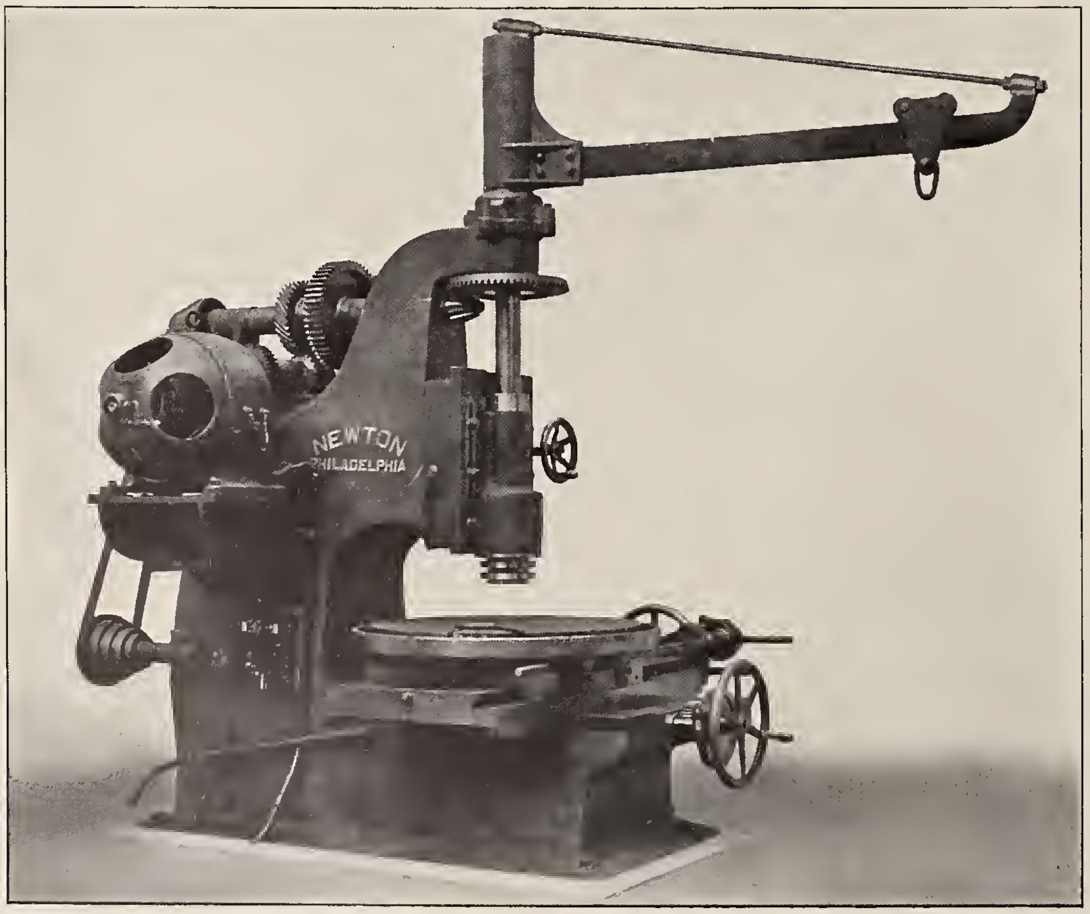


FIG. 10.—A VERTICAL MILLING MACHINE BUILT BY THE NEWTON MACHINE TOOL WORKS, PHILADELPHIA, PA., DRIVEN BY A VARIABLE-SPEED MOTOR WITH MECHANICAL SPEED CONTROL

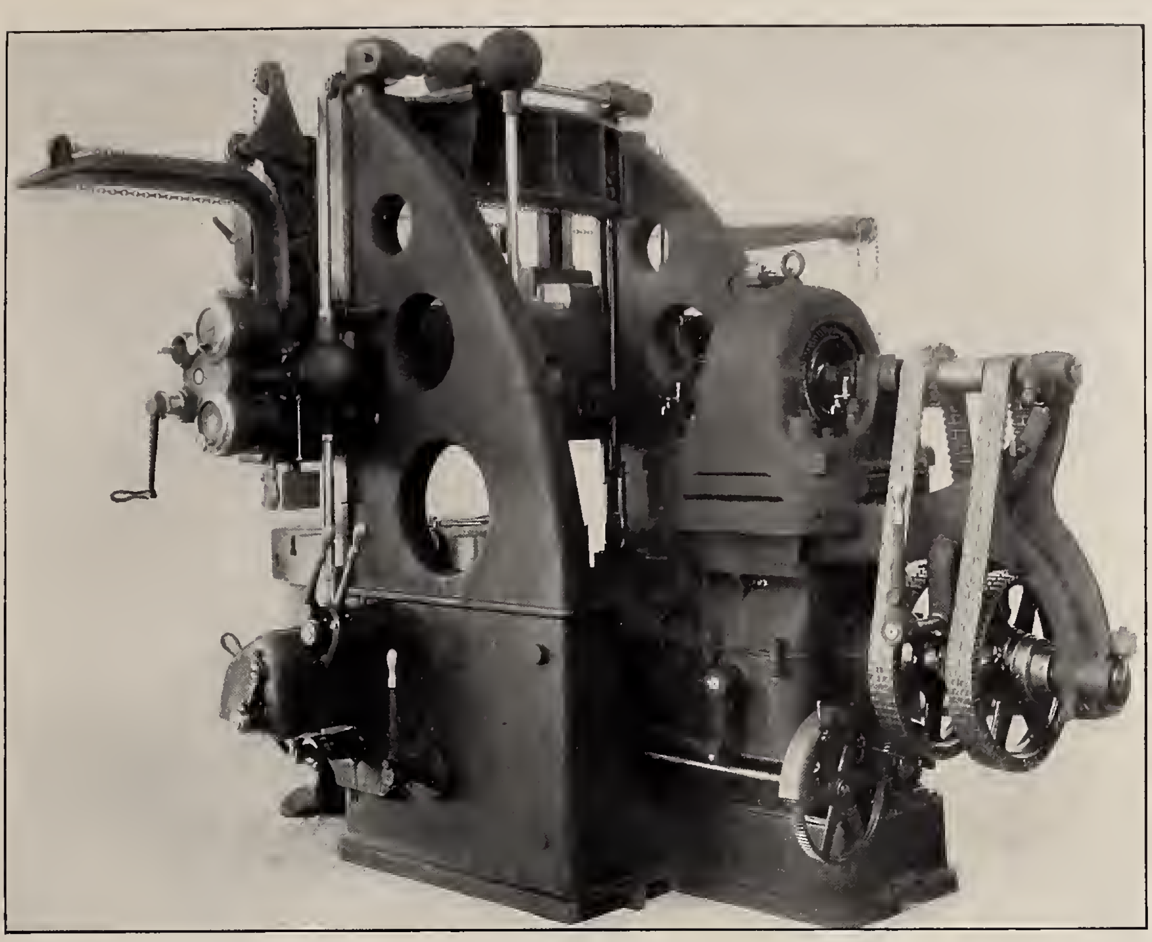


FIG. II.—A VERTICAL BORING AND TURNING MILL BUILT BY THE GISHOLT MACHINE COMPANY, MADISON, WIS., DRIVEN BY A SINGLE-PHASE MOTOR BUILT BY THE WAGNER ELECTRIC MANUFACTURING COMPANY, ST. LOUIS, MO. TWO DIFFERENT SPEEDS OF THE MAIN SHAFT OF THE MILL ARE OBTAINED BY MEANS OF THE TWO DRIVING CHAINS SHOWN

motor-driven tools is probably the breast drill, one of which, built by the Sprague Electric Company, of New York, is shown in Fig. 1. These are usual on the erecting floor of any shop, and have a great advantage over compressed air drills in that they are unencumbered by a heavy hose.

For heavier work, a radial drill of the form shown in Fig. 15 may be bolted directly to the work. This tool is built by the Hisey-Wolf Machine Company, of Cincinnati, Ohio. It has a 10-inch feed and may be used with one setting within a radius of 24 inches in any direction and at any angle. Connection may be made for the motor at any lamp socket.

Fig. 29 shows a motor-driven internal grinder built by the same company and designed for grinding and finishing gas, steam and air cylinders, grinding hardened dies, truing up bearings and for internal cylindrical grinding of any kind. It is shown bolted to the tool-post rest of a lathe.

Fig. 28 shows a portable grinder provided with a flexible shaft. The outfit is built by the Stow Manufacturing Company, of Binghamton, N. Y., the motor being of the same type as that shown in Fig. 4.

Of the heavier portable machine tools, examples of which are given in Figs. 33 and 36, it may be said that their use was necessitated by the constantly increasing size and weight of parts to be machined, and the time occupied in resetting the work for each operation. In the works of both the General Electric Company, at Schenectady, N. Y., and of the Westinghouse Electric & Manufacturing Company, at Pittsburg, Pa., machined floor plates are provided, on which the work and the tools for different operations may be placed. Numerous slots in the plates allow the work and the tool to be bolted down, the latter becoming in effect a stationary tool.

The Efficiency of Men

IN one of his recent addresses, J. Swinburne, late president of the British Institution of Electrical Engineers, said:—If one of us does $750 worth of work a year, and earns $500, he is efficient; if he only does $450 worth, he is an inefficient machine, and will come to grief. He is like a 90-KW. alternator which takes 100 KW. to excite, though the analogy is not close. If he does $75,000 worth of work and gets $50,000, he is an efficient machine of much larger size, and his efficiency is much more satisfactory to himself. I may mention, in passing, that an efficient man must do more work than he is paid for. This is not always realized. A man who only did what he was paid for would be of no use to the world at large. His efficiency is zero, his consumption being equal to his output. The man who does $75,000 worth of work and gets $50,000 consumes two-thirds of the work himself; so his efficiency is 33 per cent., which is very high, even for an engineer.

The government of Switzerland has planned to apply electricity to all the government railway lines, and to operate these lines from water-power plants, utilizing the mountain streams as a source of energy.

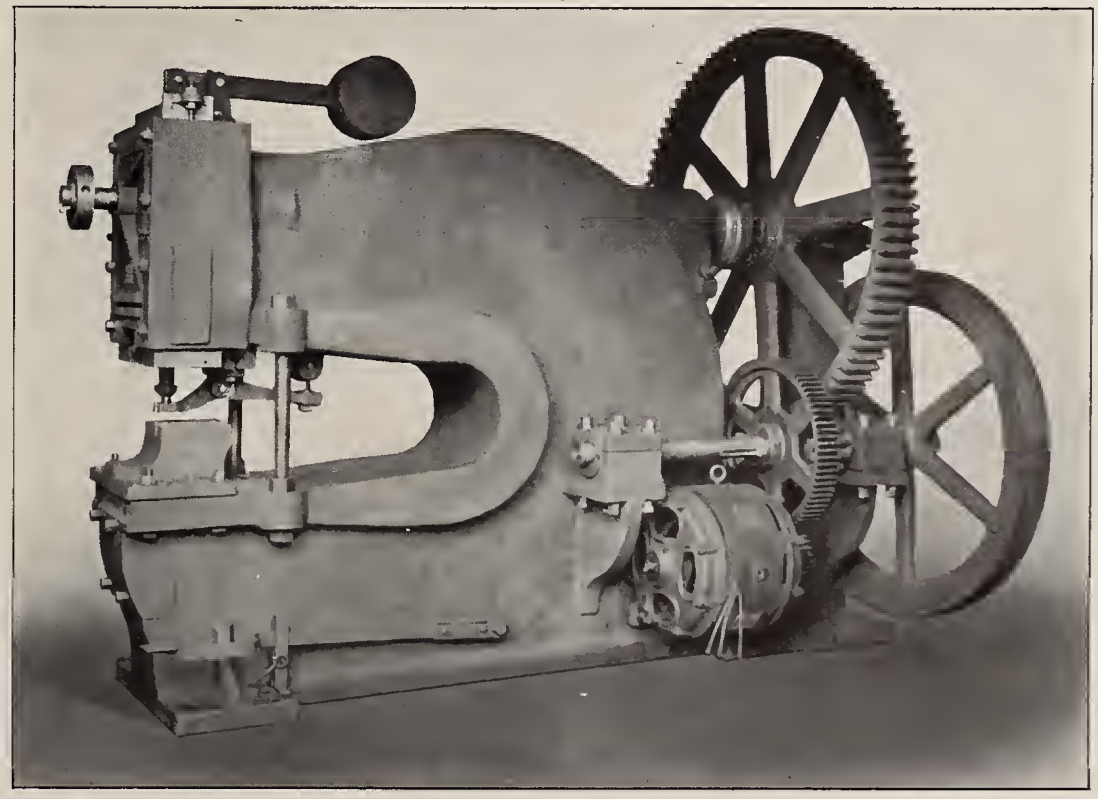


FIG. 12.—A MOTOR-DRIVEN PUNCH AND SHEAR BUILT BY THE CINCINNATI PUNCH & SHEAR COMPANY. SEE PAGE 245

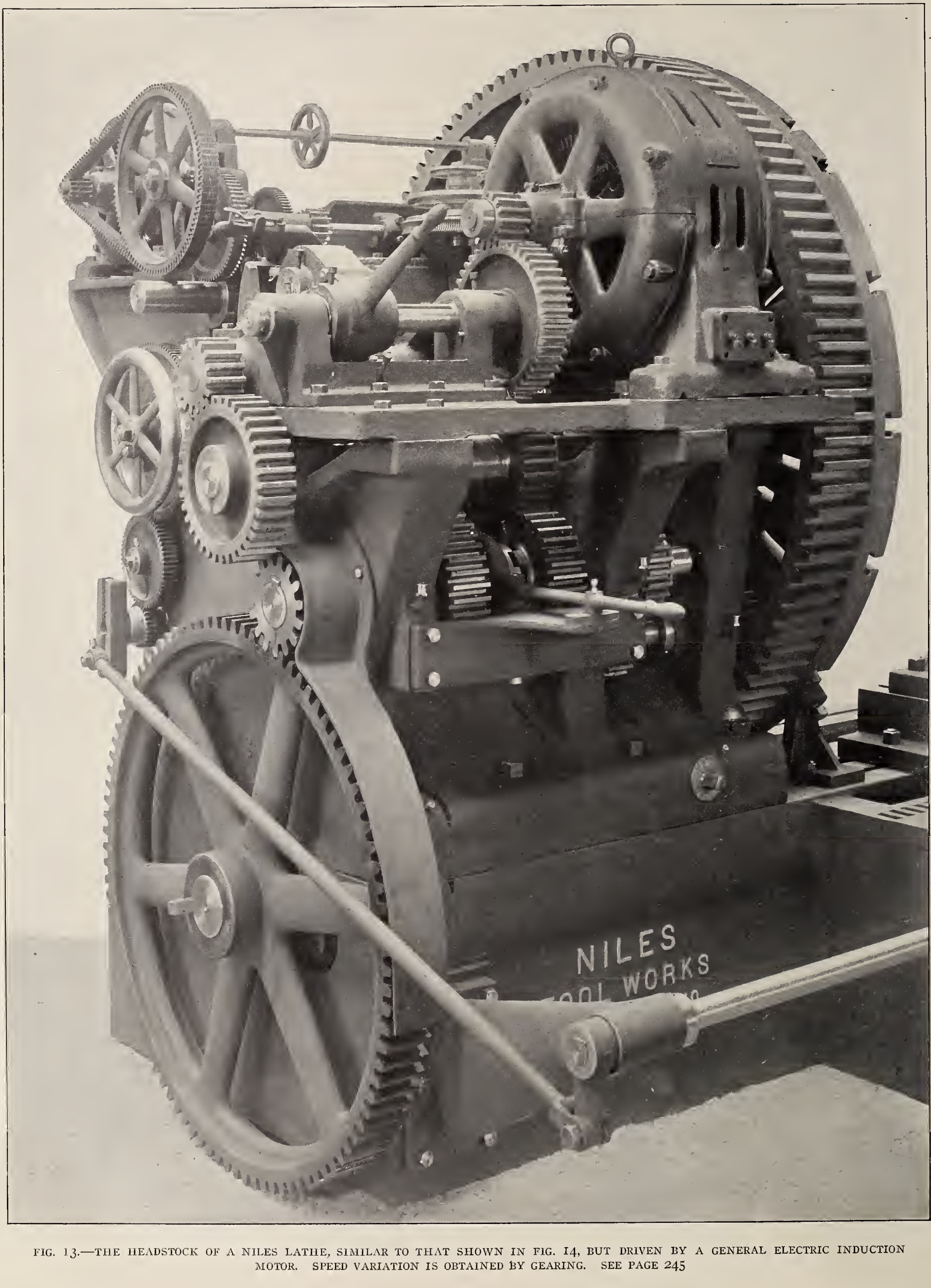


FIG. 13.—THE HEADSTOCK OF A NILES LATHE, SIMILAR TO THAT SHOWN IN FIG. 14, BUT DRIVEN BY A GENERAL ELECTRIC INDUCTION MOTOR. SPEED VARIATION IS OBTAINED BY GEARING. SEE PAGE 245

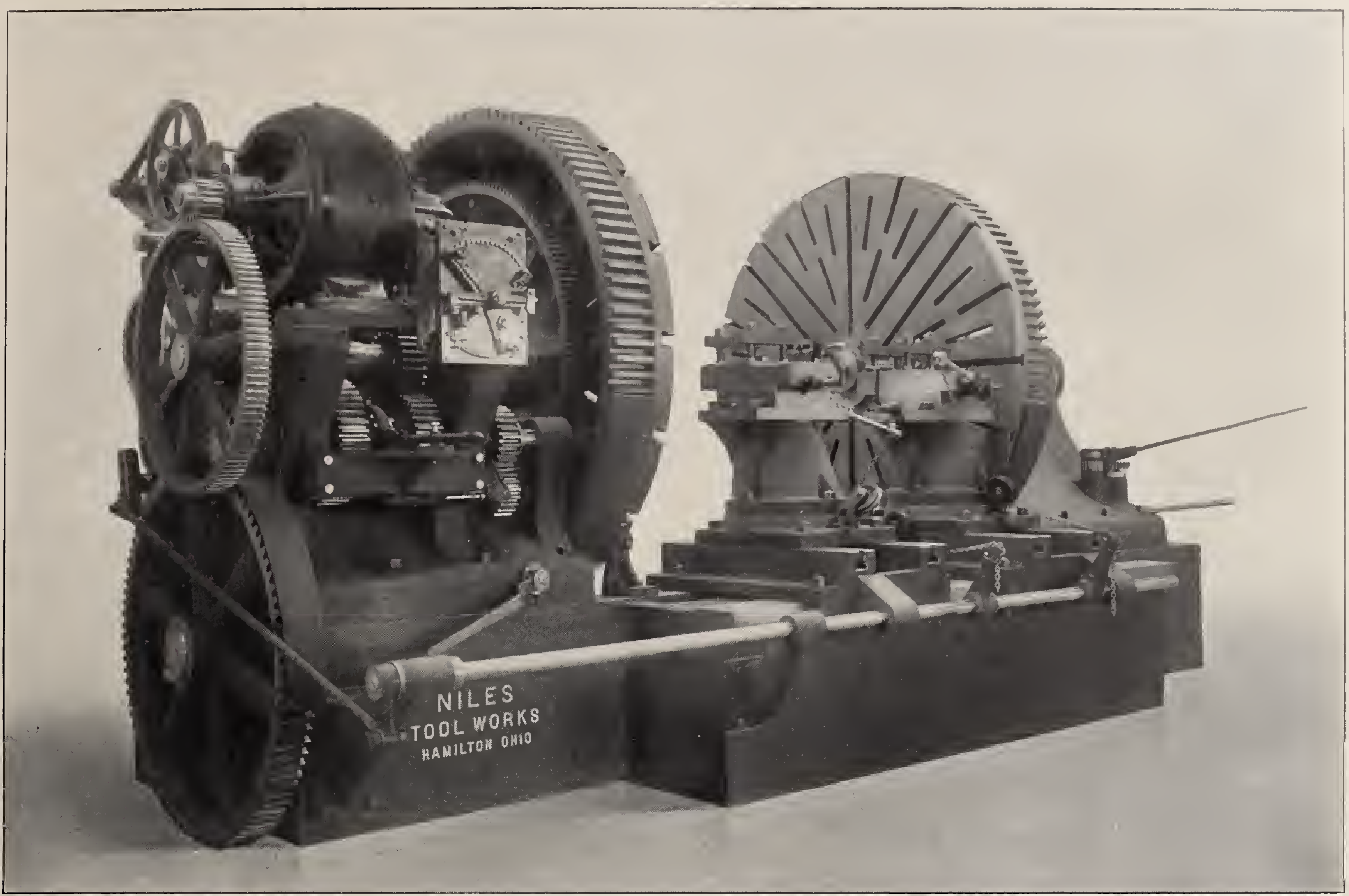


FIG. 14.—A 90-INCH NILES DRIVING WHEEL LATHE, DRIVEN BY A 20-H. P. DIRECT-CURRENT MOTOR BUILT BY THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, MADISON, WIS. SEE PAGE 245

Central Electric Light and Power Station Statistics

THE Bureau of the Census has just published a report on central electric light and power stations for the year ended June 30, 1902, prepared under the supervision of W. M. Steuart, chief statistician for manufactures. It is the third of a series of reports on the operation and utilization of electric current. In addition to the text, which was prepared by Thomas Commerford Martin, of New York City, expert special agent, there are elaborate tables and an interesting series of illustrations.

The chapters of text discuss, respectively, the scope and method of the investigation, financial operations, employees, salaries and wages, physical equipment, output of stations, franchises, and the history and development of electric lighting.

The statistics do not include isolated electric light and power plants installed in manufacturing establishments, hotels, office buildings, etc., for the purpose of furnishing the light and power primarily for the use of the individuals, firms or corporations operating such establishments.

HISTORY OF ELECTRIC LIGHTING

Electric lighting dates back only to the beginning of the last century, while the history of central stations proper belongs only to the second half or, more strictly speaking, to the last quarter of the century.

The development of electric lighting was marked by the work of a series of discoveries and inventors, by whom the evolution of arc lighting from an expensive laboratory experiment to its present cheap and useful form was accomplished.

The progressive success of arc lighting imparted a great impulse to experimentation with the incandescent lamp. Many distinguished inventors devoted their attention to this subject, but the incandescent lamp was not commercially a success until about twenty-five years ago, when Edison's first lamps were produced.

To Mr. Edison the development of the incandescent lamp was associated with the creation of a complete system of electric lighting, a current to be furnished from the central station to a large number of buildings in a manner exactly analogous to that in which the supply of gas is furnished. In 1880 he installed such a system in Menlo Park. The introduction of the Edison "Jumbo" dynamo soon followed.

The estimated useful life of a 100-Watt 16-candle-power lamp made to-day is over 10,000 hours, about

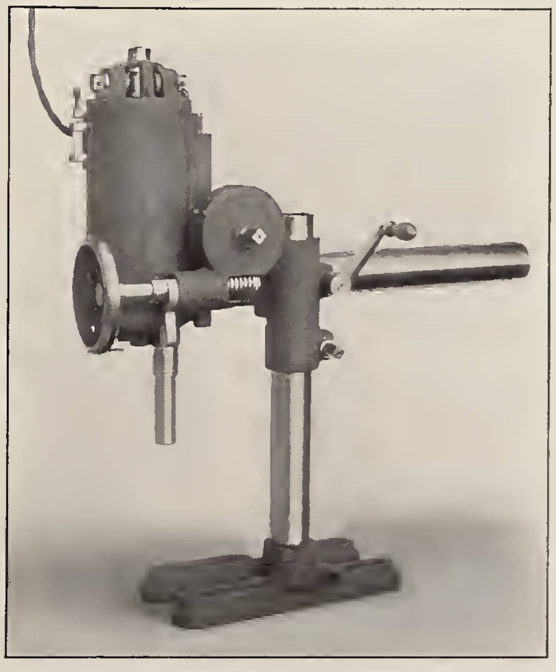


FIG. 15.—AN ELECTRICALLY-DRIVEN RADIAL DRILL BUILT BY THE HISEY-WOLF MACHINE COMPANY, CINCINNATI, OHIO. SEE PAGE 246

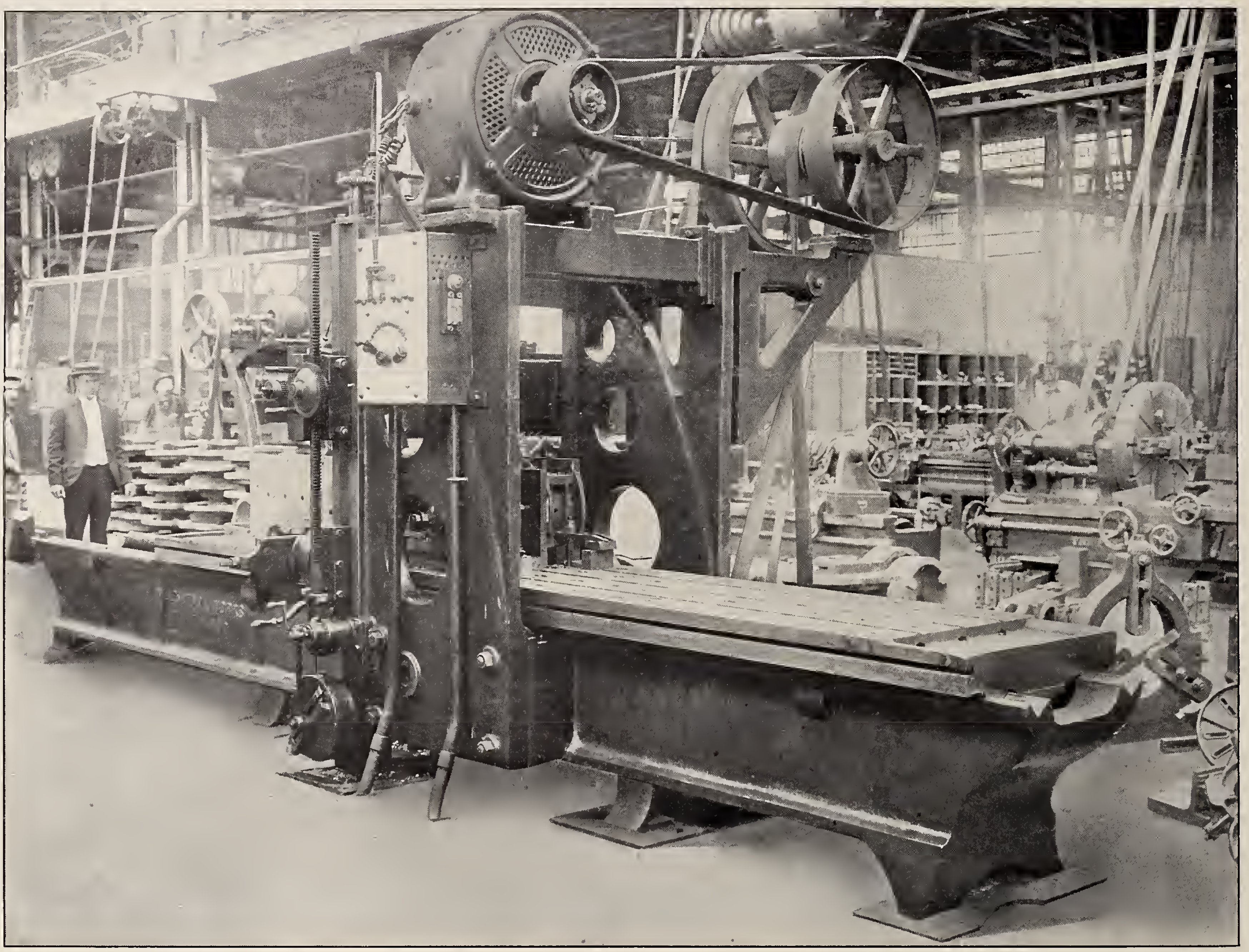


FIG. 16.—A PLANER BUILT BY THE NILES-BEMENT-POND COMPANY, DRIVEN BY A MOTOR BUILT BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURG, PA. THE HEAVY REVERSING PULLEY ACTS AS A FLY-WHEEL TO TAKE THE STRAIN OFF THE MOTOR AT REVERSAL. SEE PAGE 246

twenty times as long as it was twenty-five years ago.

In the last quarter of a century a total of over 250,000,000 lamps has been produced, or not less than 10,000,000 a year.

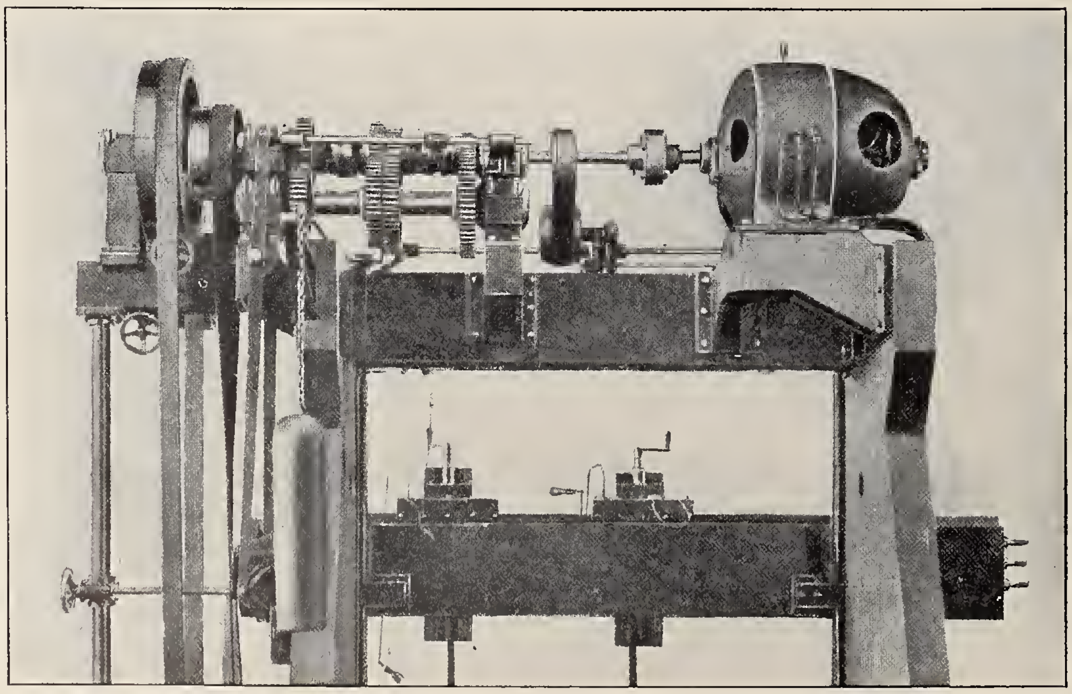


FIG. 17.—AN ELECTRIC DRIVING MECHANISM CAPABLE OF GIVING DIFFERENT SPEEDS TO A PLANER TABLE DURING THE CUTTING STROKE. DESIGNED BY THE CROCKER-WHEELER COMPANY, AMPERE, N. J., U. S. A. SEE PAGE 246

Then came the attempt to unify arc and incandescent lighting, the development of the use of the alternating current, the evolution of the later arc lamps, the change from open to inclosed lamps, the production of lamp globes, lamp supports, series and multiple methods, appliances, fixtures, fuses and cut-outs, methods of wiring, modern conveniences, and novel types of lamps, including the Nernst incandescent, the mercury vapour, and vacuum tube lighting.

GROWTH OF THE INDUSTRY

For convenience in study the various electric stations have been divided into two grand classes: First, those operated by individuals or corporations, and, second, those operated under municipal control. Each of these classes is subdivided into, first, those doing a purely electric business, and, second, those operated in connection with other industries. The latter are designated composite stations.

Further subdivisions have been

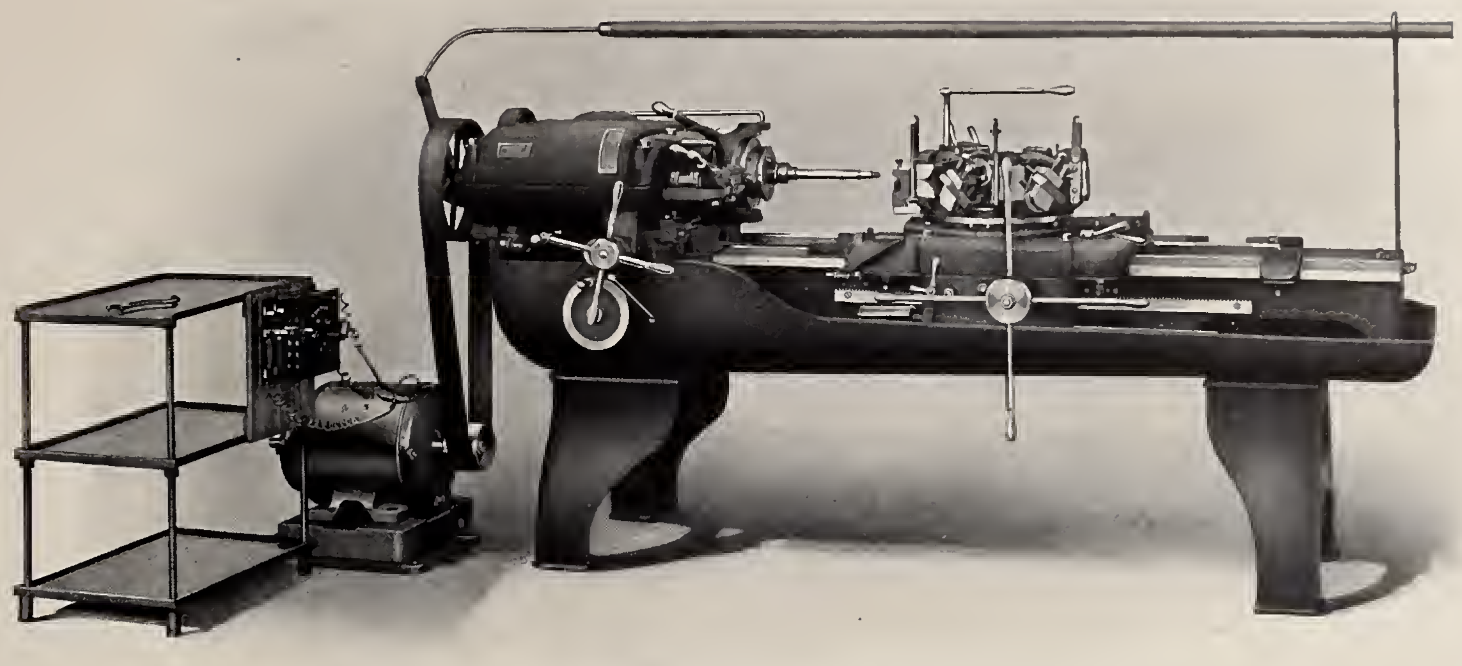


FIG. 18.—A FLAT-TURRET LATHE WITH CROSS-SLIDING HEAD, MADE BY THE JONES & LAMSON MACHINE COMPANY, SPRINGFIELD, VT., DRIVEN BY A BULLOCK MOTOR. SEE PAGE 241

made, one being based upon the population of the place in which the station is located and the other upon the horse-power capacity of the generating apparatus of the station.

The growth of this industry is shown by the following figures: From eight stations beginning operation in 1881 the number rose to 100 in 1886, to 208 in 1889, and to 247 in 1892. During the following years of depression the number of new stations fell; but in 1895, though a time of financial stringency, it again rose to 239. In 1898 it reached 277, or more than the number beginning operation in the entire period from 1881 to 1886, inclusive. The number for 1901 was 250, and for five months of 1902 it was 146. In the twenty years from 1881 to 1901, inclusive, an average of 165 private and municipal stations have begun operation each year. The spread of the agitation for municipal ownership of public service enterprises is illustrated in a somewhat striking manner. Of the 815 municipal stations enumerated, only 68 had been installed up to 1889. In that year 40 were introduced, and in 1895 the number of new stations reached 73, increasing in 1898 to 82. The returns for 1902 indicate that the ratio was fully maintained in the census year.

In 1902 there were in the United States 3620 central electric stations, with a cost of construction and equipment of $504,740,352. Employed were 6996 salaried officials and clerks with salaries amounting to $5,663,580; and 23,330 wage-earners with wages amounting to $14,983,112. The gross income was $85,700,605, comprising $84,186,605 from sale of current, and $1,514,000 from other sources. Total expenses were $68,081,375. The total output of stations

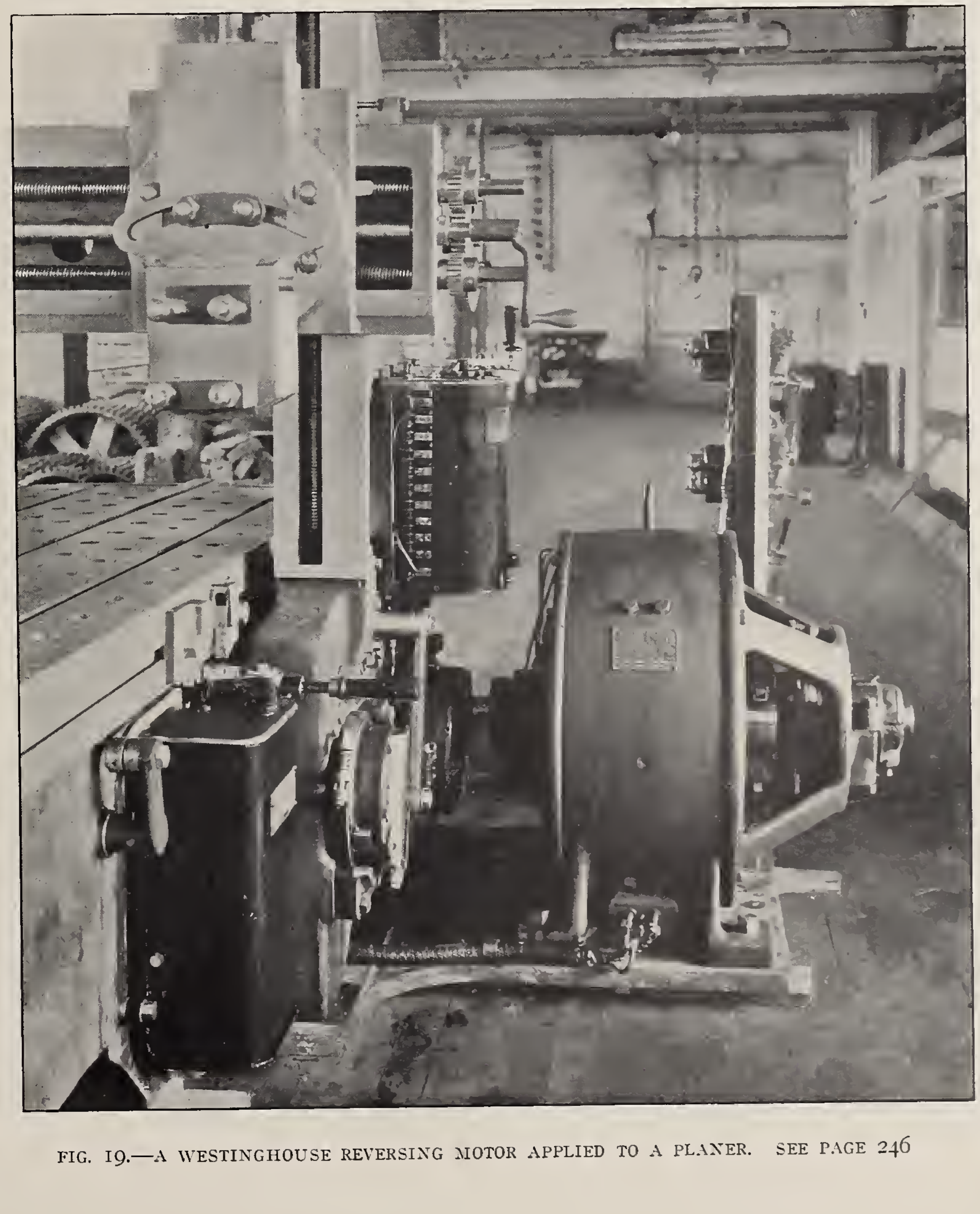


FIG. 19.—A WESTINGHOUSE REVERSING MOTOR APPLIED TO A PLANER. SEE PAGE 246

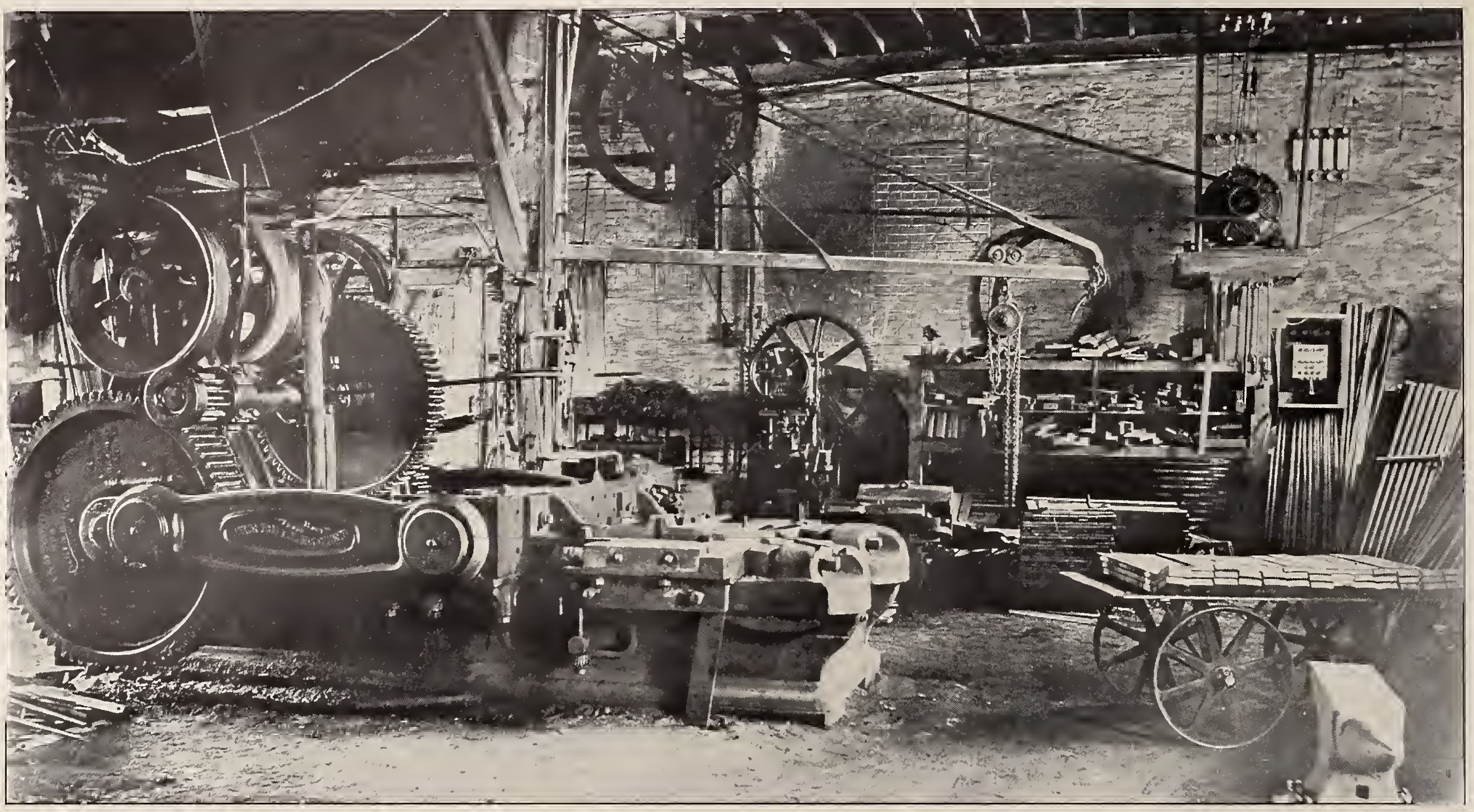


FIG. 20.—INDUCTION MOTORS BUILT BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, OPERATING IN THE BLACKSMITH SHOP OF THE ADVANCE THRESHER COMPANY, BATTLE CREEK, MICH. THE MOTORS ARE EASILY PLACED ENTIRELY OUT OF THE WAY. SEE PAGE 241

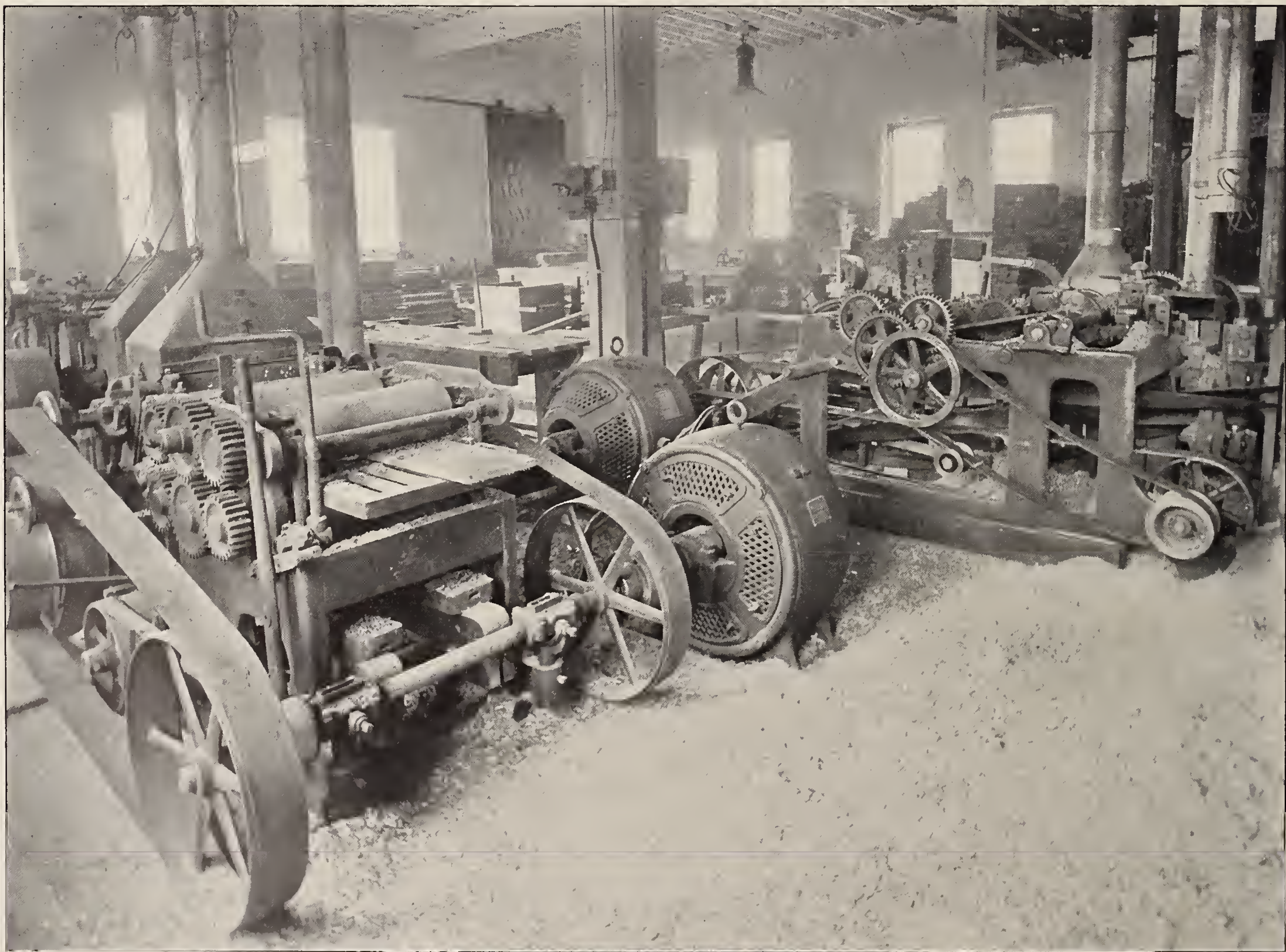


FIG. 21.—A WOOD-WORKING SHOP EQUIPPED WITH WOOD-WORKING MACHINES BUILT BY THE J. A. FAY & EGAN COMPANY, CINCINNATI, DRIVEN BY WESTINGHOUSE MOTORS. SEE PAGE 241

for the year, in kilowatt-hours was 385,698, and of incandescent lamps, 18,194,044.

There has been a striking change in the character of service in these stations. In the earlier days of the industry nearly all the stations were installed for the purpose of furnishing current for arc lighting, while to-day the bulk of current is supplied for incandescent lighting, motor power, and miscellaneous service. This last includes charging telephone exchanges, batteries for boats and automobiles, pumping, hot water, steam, and electric heating; electric current, and nickel plating and electroplating.

COMPARISON OF PRIVATE AND MUNICIPAL STATIONS

Private stations form by far the largest portion of the industry, constituting 77.5 per cent. of the total number of stations in operation during 1902. Their income from sale of current was $78,735,500, or 91.9 per cent. of gross income, the expenses of operation 92.3 per cent. of the total, while they gave employment to 89.4 per cent. of the total number of wage-earners engaged in the industry and paid 90.5 per cent. of the total amount of annual wages. The primary power plant equipment of these stations formed 91.3 per cent. of the total horse-power of all stations, while their generating equipment formed 90.6 per cent. of the total horse-power of all dynamos. The kilowatt-hour output of private stations formed 92.2 per cent. of the total, and the arc lamps in such stations formed 86.8 per cent. of the total number wired for operation.

The comparison of the income of the two classes of stations is not a fair indication of their earning capacity, because of the gross income reported for municipal stations. Of this gross income, $6,836,856 resulted from the sale of current, and included income from public service which was necessarily largely, if not wholly, a matter of estimation.

The private stations employed 20,863 wage-earners, who were paid $13,560,771, and 6046 salaried officials and clerks with salaries amounting to $5,206,199; while the municipal stations employed 2467 wage-earners, who were paid wages amounting to $1,422,341, and 950 salaried officials and clerks, who were paid $457,381.

The cost of construction and equipment of the municipal stations was only 4.4 per cent.; their income from sale of current, 8.1 per cent.; their expenses were 7.7 per cent.; and the horse-power capacity of their power and generating plants was 8.7 and 9.4 per cent., respectively. The output of such stations was 7.8 per cent of the total kilowatt-hours produced by all the stations, while their arc lamps were 13.2 per cent., and their incandescent lamps, 8.7 per cent. of all the lamps reported for the country.

In addition to controlling practically the entire industry, the average private station is much larger than

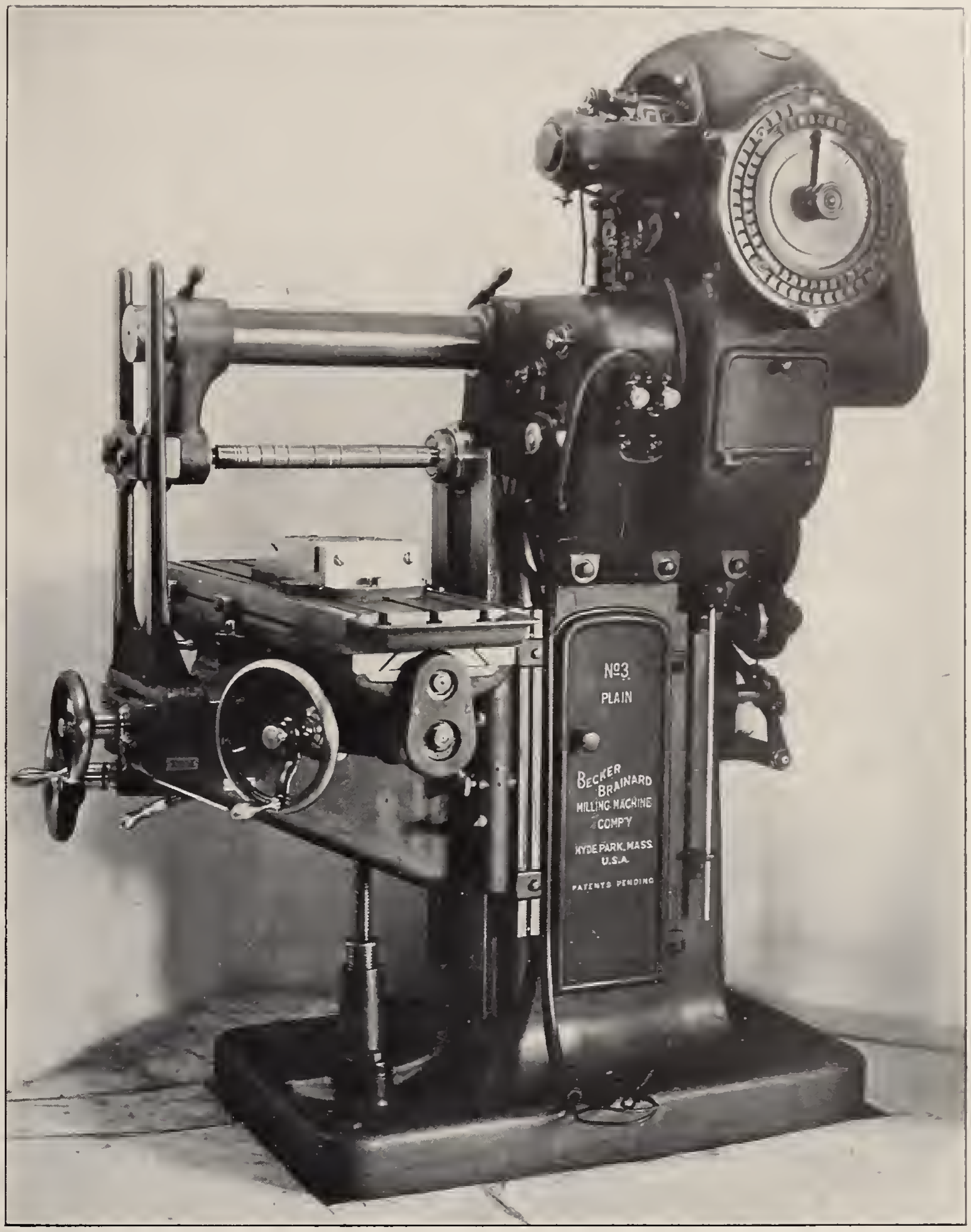


FIG. 22.—AN ELECTRICALLY-DRIVEN MILLING MACHINE BUILT BY THE BECKER-BRAINARD MILLING MACHINE COMPANY, HYDE PARK, MASS. SEE PAGE 241

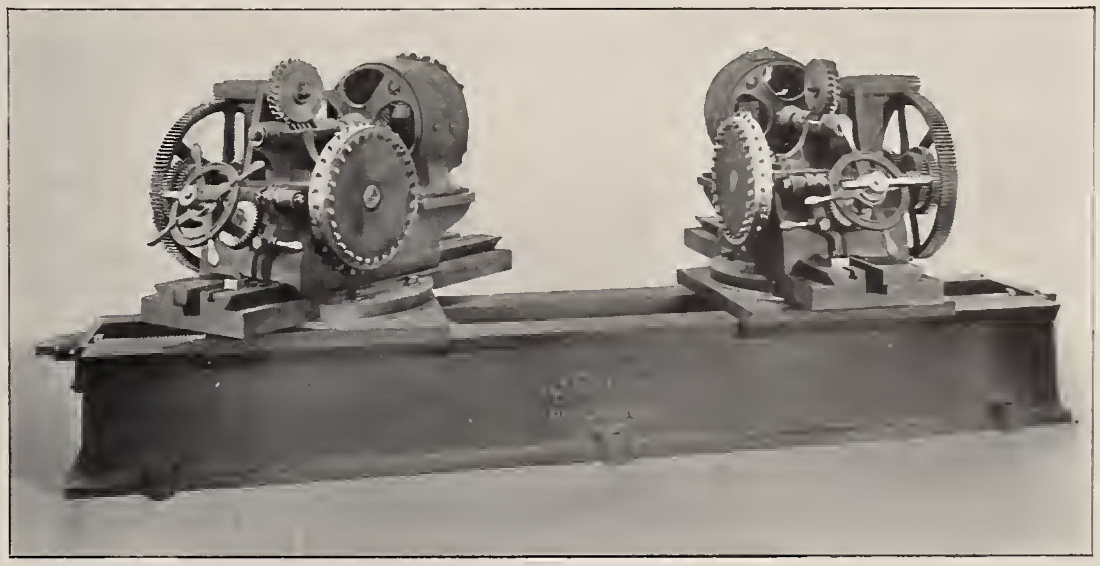


FIG. 23.—A DUPLEX ROTARY PLANING MACHINE WITH SWIVELLING HEADS. BUILT BY THE NEWTON MACHINE TOOL WORKS, PHILADELPHIA, PA., AND DRIVEN BY 5-H. P. MOTORS. SEE PAGE 241

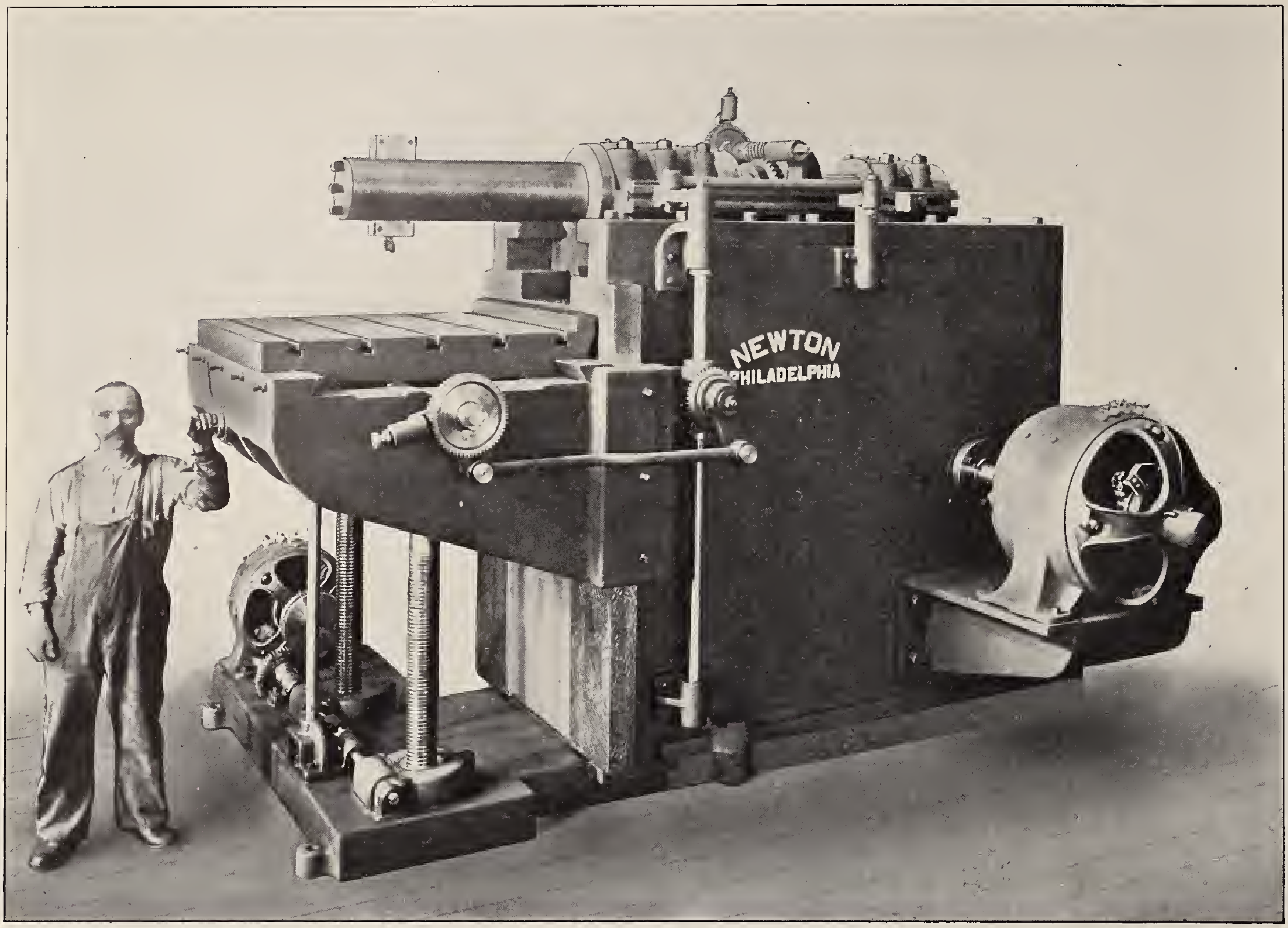


FIG. 24.—AN ELECTRICALLY-DRIVEN SHAPING MACHINE BUILT BY THE NEWTON MACHINE TOOL WORKS, EQUIPPED WITH MOTORS BUILT BY THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y. SEE PAGE 241

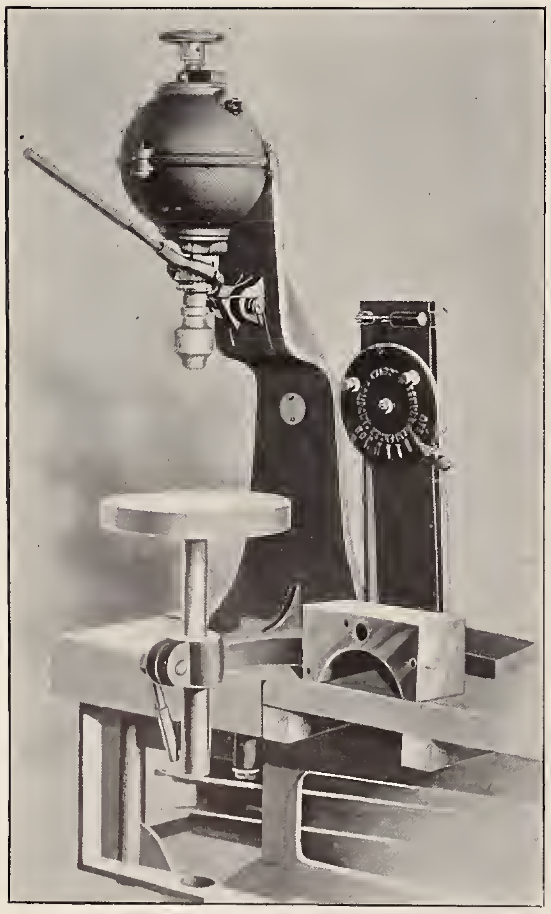


FIG. 25.—A BENCH DRILL DRIVEN BY A VERTICAL MOTOR BUILT BY THE SPRAGUE ELECTRIC COMPANY. SEE PAGE 241

the average municipal station. Considering the total of 2805 private stations, it appears that the average total expense per year station was $22,401, as compared with $6437 for municipal stations. The private stations gave employment on the average to 7.4 wage-earners, while the municipal stations gave employment to 3. The average private stations reported 823,938-KW. hours per year, as compared with 240,373 for the municipal stations.

It is found that 732 municipal stations operated in that number of communities in which there was no competitive private service. It would appear that in all probability a great many if not all of these places would have gone without electric lighting had the supply been left to private enterprise seeking a return upon its investment. The population served by these stations was 2,052,485, an average of a little over 2800 per station, and towns of this size rarely offer inducements to private capital, regarded from the per capita basis of consumption of current. These stations also represent a total cost of construction and equipment of $15,369,382, or about $21,000 per station, whereas the average cost of construction and equipment for the 3620 central stations of all classes was slightly short of $140,000. The largest average population per community is shown for Massachusetts, having 17 stations, with an aggregate population of 151,407, or an average of 8906. The smallest population per community is shown for Colorado, with two municipal stations supplying 1402 people, or an average of 701 for each station. An average of five persons to a family or house would give barely 140 houses.

DISTRIBUTION OF STATIONS

The largest number of stations was in Illinois, followed by Pennsylvania, New York, Ohio, Michigan, Indiana, Iowa and Wisconsin in the order named. No other State reached the 150 mark. The New England States were well supplied with stations. Massachusetts reported the largest number, then came Maine, Vermont, New Hampshire and Connecticut. Among the Southern States Texas

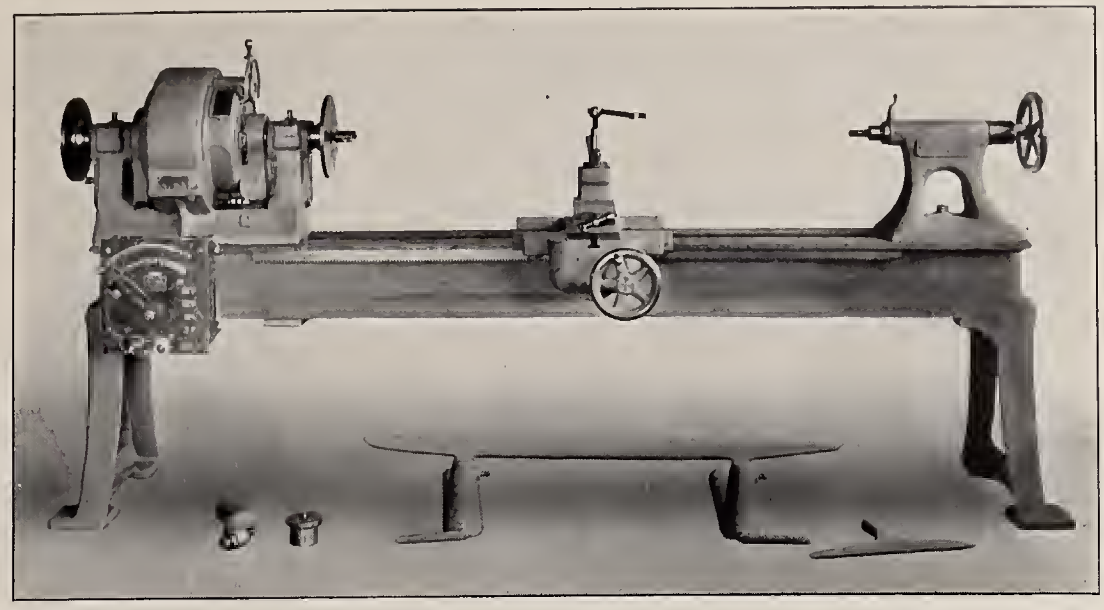


FIG. 26.—A WOOD-TURNING LATHE BUILT BY THE J. A. FAY & EGAN COMPANY, CINCINNATI, OHIO, DRIVEN BY A MOTOR BUILT BY THE TRIUMPH ELECTRIC COMPANY, CINCINNATI, OHIO. SEE PAGE 241

led, with Kentucky, Tennessee and Georgia following. Of the Western States, California reported the largest number of stations, Colorado, Washington, Oregon and Montana being next in order. Of the 1892 places reported at the twelfth census as having a population of 2500 and over, 1511 had one or more central electric lighting stations. Of the places with a smaller population, 1960 had similar stations.

LONG-DISTANCE TRANSMISSION STATIONS

A number of companies supply areas of many square miles in which are located scores of cities, towns, incorporated villages, and mere hamlets, all enjoying the benefits of electricity and constituting a source of income for the enterprise. The extreme limit of such work at the time of this report was marked by the long-distance power transmission on the Pacific Coast, where current from the Sierras was actually delivered for general consumption in San Francisco and Sausalito, and was also distributed from the same plants over lines which ramify into half the counties of the State of California. The whole aspect of central station current supply in its relation to population has in reality been utterly changed by the development of polyphase power transmission plants. There are at least a thousand such plants, with lines frequently 15 to 20 miles long, in many cases 40 or 50 miles, often 60 or 90 miles, and sometimes even 150 or 200 miles.

These transmission enterprises are peculiarly typical of the far Western States, but are by no means concentrated there, being scattered all over the Union.

FINANCIAL OPERATIONS

The total capital stock and funded debt authorized amounted to $743,296,266, but the amount issued was considerably less, being $627,515,875. Of the total amount authorized, $435,178,372, or 58.5 per cent., was capital stock, and $308,117,894, or 41.5 per cent., was funded debt. Of the total authorized capital stock, $372,951,952, or 85.7 per cent., had been issued at the end of the year covered by the report. Of the capital stock issued, $23,871,671, or 6.4 per cent., was preferred stock and $349,080,281, or 93.6 per cent., was common stock.

Private stations expended $40,050,613, and municipal plants $1,741,834 in construction and equipment during the year covered by the report. The total for private stations from their origin until 1902 was $482,719,879, giving an average outlay of $328 per horse-power of dynamo capacity. It is interesting to compare these figures with those for municipal stations, which show a cost for construction and equipment of $22,020,473, and an average of about $145 per horse-power of generating capacity; it is not safe to accept this average as a basis of comparison, on account of the wide variations revealed in the different States, which range from $114 in Ohio to $844 in the State of Washington.

Although the practice of supplying current for motive power and other uses had grown rapidly, the supplying of current for light was still preponderatingly the business of both private and municipal stations. Of the total income, $70,138,147, or 81.8 per cent., was directly derivable from lighting. The private stations obtained 80.5 per cent., and the municipal stations 96.9 per cent. of their income from this source. This income from sale of current for lighting purposes was derived from 385,698 arc lamps and 18,194,044 incandescent lamps. The average income per lamp for arc lights in private stations and

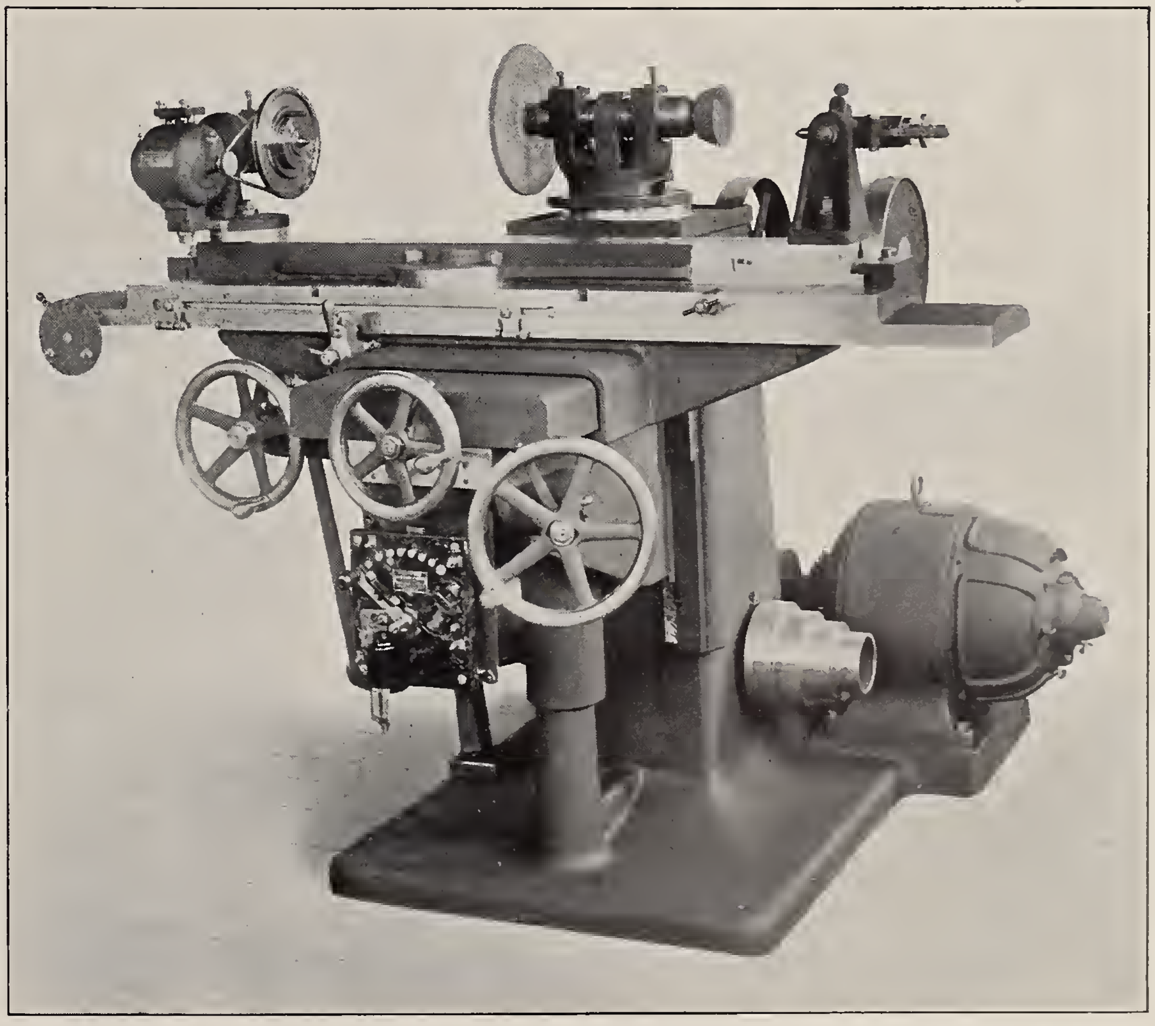


FIG. 27.—THE LATEST GRINDER MADE BY THE CINCINNATI MILLING MACHINE COMPANY, CINCINNATI, OHIO. DRIVEN ELECTRICALLY AS SHOWN. SEE PAGE 241

FIG. 28.—A MOTOR-DRIVEN PORTABLE EMERY GRINDER. THE MOTOR IS OF VARIABLE SPEED, AND IS BUILT BY THE STOW MANUFACTURING COMPANY. SEE PAGE 247

used for commercial or other private lighting was $48.88; used for public lighting, $83.20. In municipal stations, for commercial or other private lighting, it was $41.46; for public lighting, $60.98. The incandescent lamps in private stations in commercial use earned an average income of $2.40 per lamp; in public service, $6.06. In municipal stations these lamps earned $1.92 in commercial service and $5.93 in public service.

The total expenses for private and municipal stations were $68,081,375. Of this, $20,646,692 was for salaries and wages; $22,915,932, for supplies, materials, and fuel; $11,805,206, for rents, taxes, insurance, and miscellaneous expenses; and $12,623,545, for interest on bonds.

PHYSICAL EQUIPMENT

This subject is considered under the three heads: Power and generating equipment, line construction, and service line equipment. The power plant equipment showed 5930 steam engines with 1,379,941 H. P., and 1390 water-wheels with 438,472 H. P.; and the generating plant equipment, 3823 direct-current, constant voltage dynamos with 442,446 H. P.; 3539 direct-current constant amperage dynamos with 195,531 H. P.; and 5122 alternating and polyphase current dynamos with 987,003 H. P. The line construction had 107,263 miles of mains and 17,880 miles of feeders. For the service line equipment, meters, lamps, and motors are the important items. There were 582,689 meters; 575,004 of these were mechanical and 7685 chemical. The aggregate of arc lamps of all classes was 385,698, of which 334,903, or 86.8 per cent., were operated from private stations and 50,795, or 13.2 per cent., from municipal stations. In addition to these 385,698 arc lamps connected to the circuits of central stations, the street railways operating electric lighting stations reported 33,863 arcs, making the total for the United States 419,561.

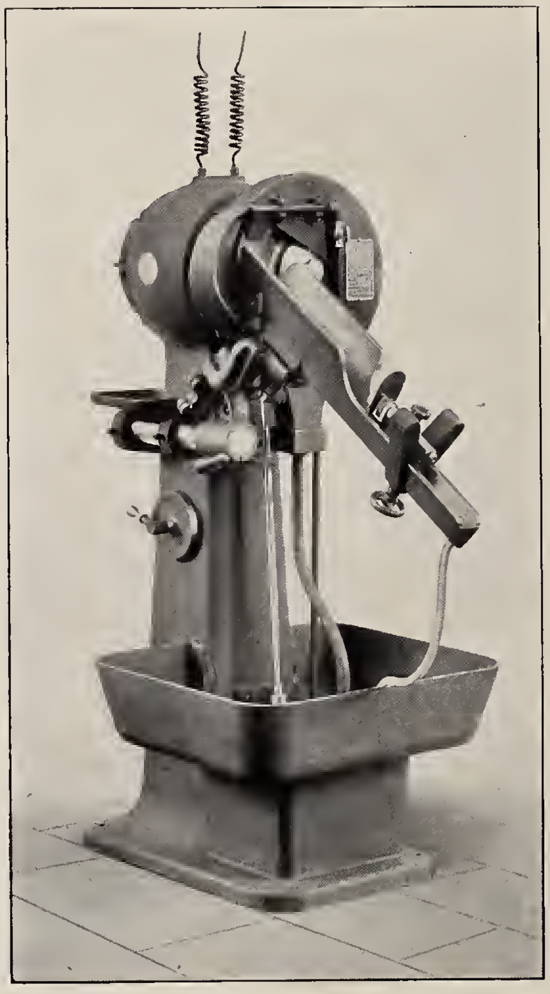


FIG. 30.—AN ELECTRICALLY-DRIVEN DRILL GRINDER MADE BY THE WILMARTH & MORMAN COMPANY, GRAND RAPIDS, MICH. SEE PAGE 241

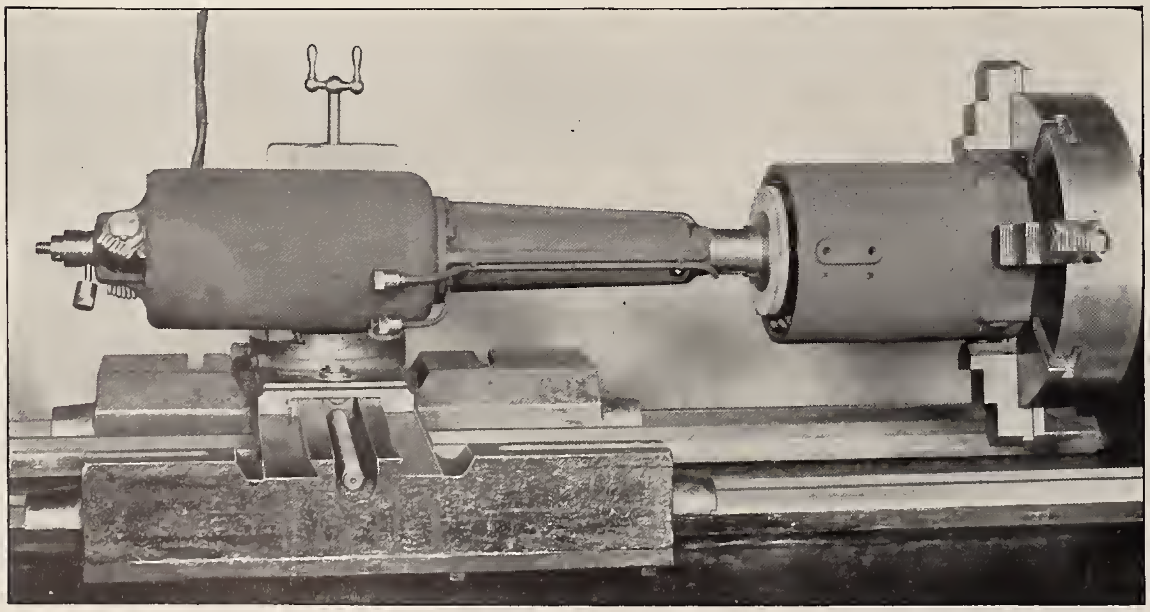


FIG. 29.—AN ELECTRICALLY-DRIVEN INTERNAL GRINDER BUILT BY THE HISEY-WOLF MACHINE COMPANY. SEE PAGE 246

OUTPUT

The main function for which a central station exists is the generation of current, for the measurement of which the kilowatt-hour is the unit

now universally accepted. Using this as the unit, the average output of current per day for all stations was 6,960,783, making a total for the year of 2,507,051,115. For private stations the output was 2,311,146,676 KW. hours, and for municipal stations, 195,904,439. Among the private stations the totals for New York are at the head of the list; among the municipal, Illinois.

FRANCHISES

Electric lighting, street railway and other analogous corporations derive their charters, which give them the right to exist and which regulate in a general way their internal government, from the state through the medium of either a general or special statute. Usually further definite authorization is necessary before wires may be run along a specified street or highway, and it is this authorization that is designated by the term "franchise" in the more limited sense.

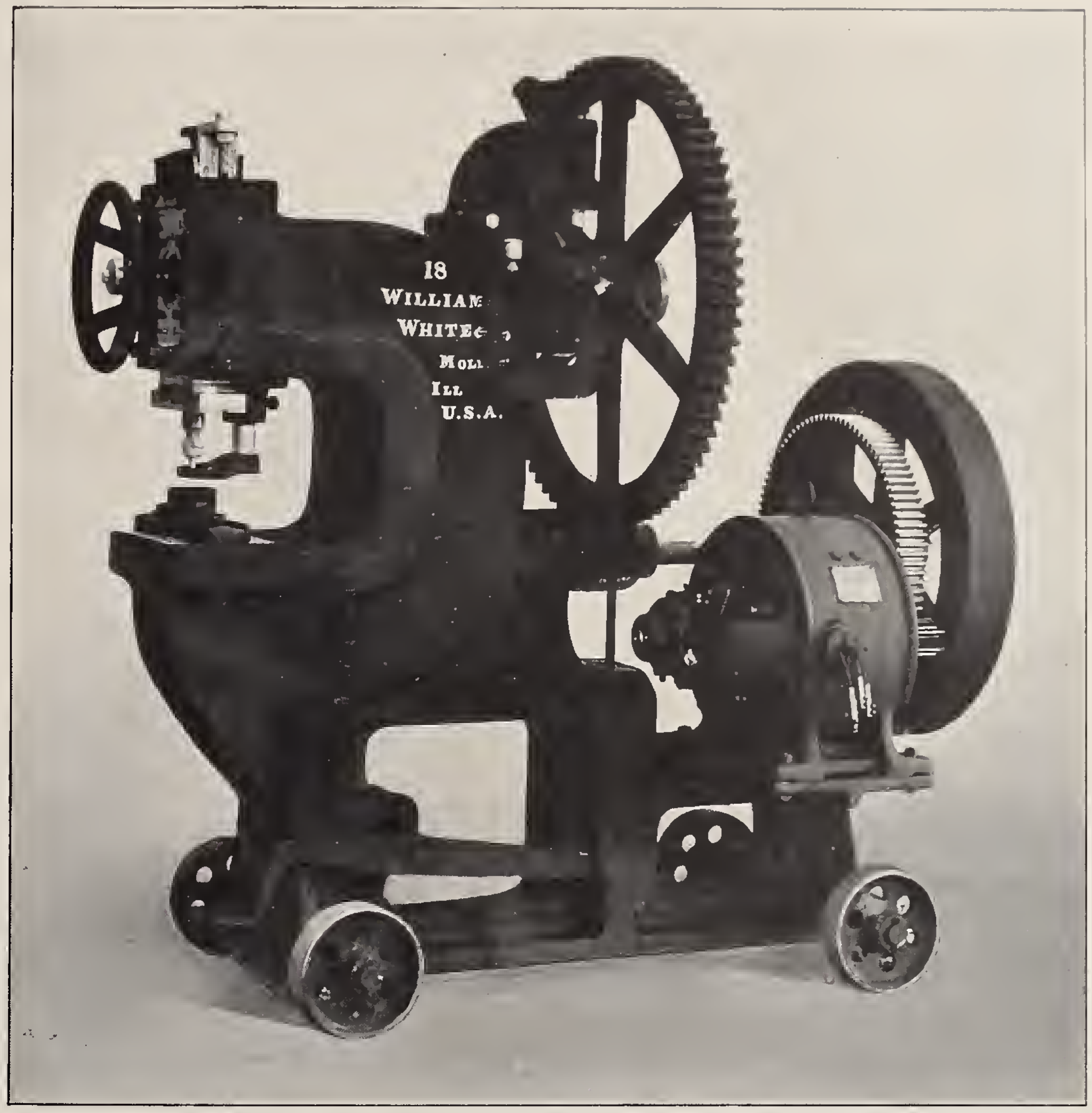


FIG. 31.—A MOTOR-DRIVEN PORTABLE PUNCHING MACHINE BUILT BY MESSRS. WILLIAMS, WHITE & COMPANY, MOLINE, ILL. SEE PAGE 241

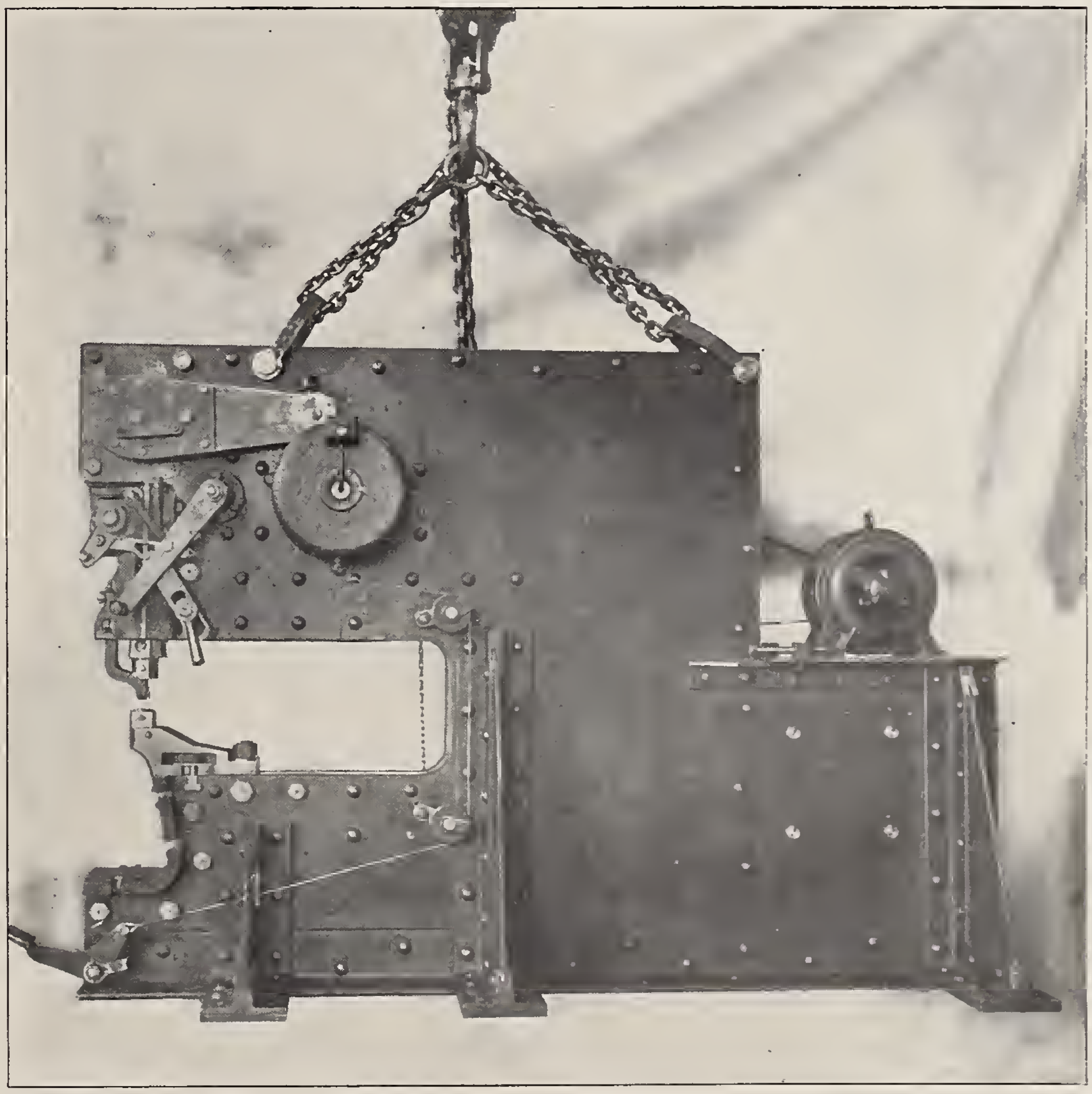


FIG. 32.—A MOTOR-DRIVEN PORTABLE PUNCHING MACHINE MADE BY HENRY PELS & COMPANY, NEW YORK. SEE PAGE 241

Submarine Sound Signaling

At a meeting of the British Institution of Naval Architects, held a short time ago, J. B. Millet read a paper on "Submarine Signaling by Means of Sound." While this subject has already been referred to a number of times in these pages within the past eighteen months, Mr. Millet in his paper brought out several details not previously touched upon; hence the following extracts from his remarks:—

The earliest workers in the field relied upon telephonic electrical apparatus attached to the outside of the vessel, or lowered overboard into the water, while no one seems to have thought of using the ship itself as a collector of submarine sound. Blake established the important fact that sound in the water surrounding a ship would pass readily through its walls into the hold. Mundy, and also Gray, made experiments on the sea-shore near Boston, submarine bells and various types of transmitters being used. Mundy ultimately placed sound transmitters inside the ship, they being situated in small tanks attached to the skin of the vessel. The tanks were filled with a solution, the microphone being wholly immersed. The difficulty here was that the ship's own noises filled the microphone with a roar, and completely shut out all bell or other sounds. The devices were therefore towed overboard; but these forms could not be used to ascertain the direction from which the submarine sounds

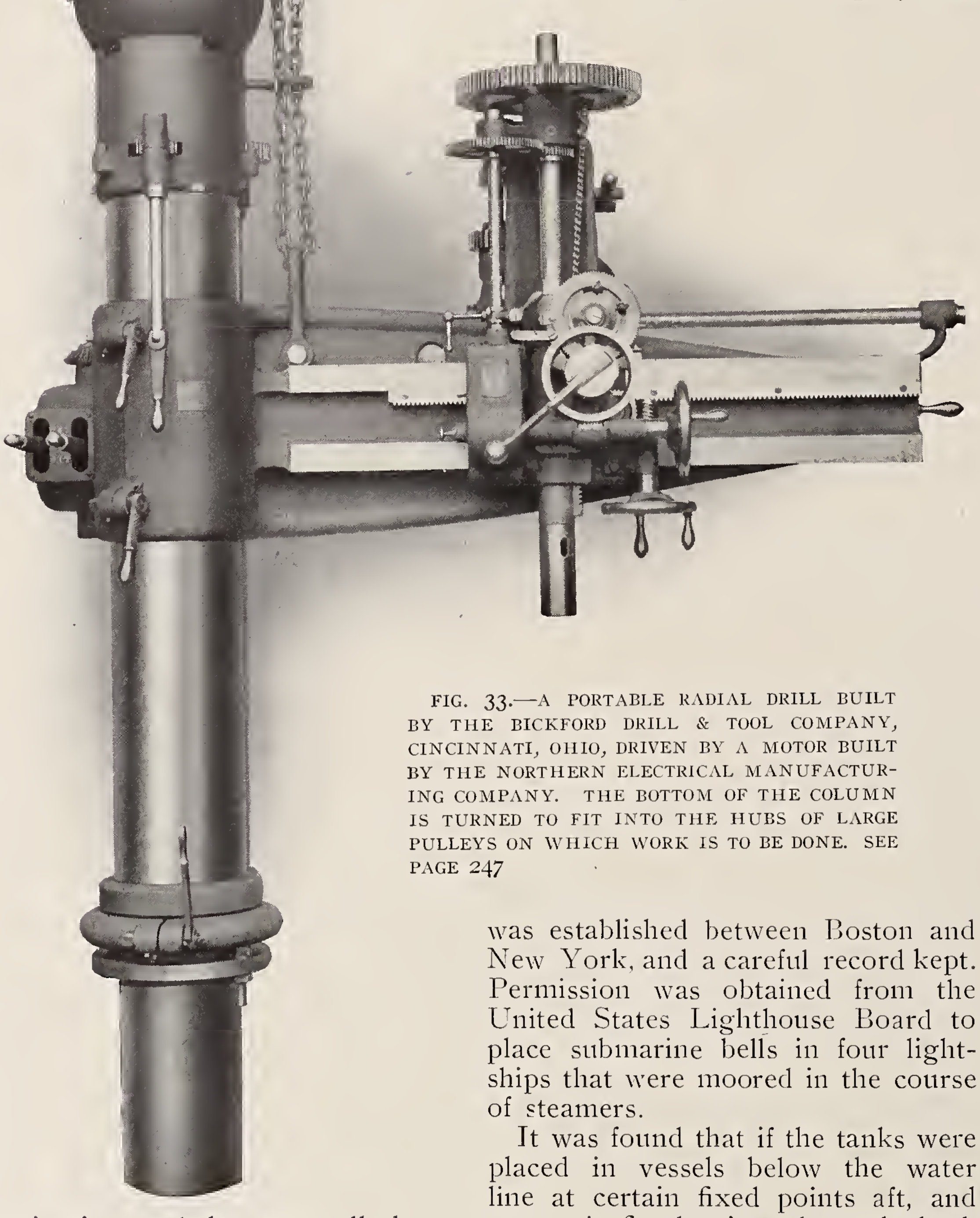


FIG. 33.—A PORTABLE RADIAL DRILL BUILT BY THE BICKFORD DRILL & TOOL COMPANY, CINCINNATI, OHIO, DRIVEN BY A MOTOR BUILT BY THE NORTHERN ELECTRICAL MANUFACTURING COMPANY. THE BOTTOM OF THE COLUMN IS TURNED TO FIT INTO THE HUBS OF LARGE PULLEYS ON WHICH WORK IS TO BE DONE. SEE PAGE 247

were issuing, and they were all abandoned.

It was ultimately found that the tank with the immersed microphone was the key to the whole situation, and the proportions of the tank were found to be important—for it often appeared as if the tank were acting as a resonator of sound. Up to this time, the paper stated, nearly $100,000 had been spent, and the practical results were meagre enough to discourage any but enthusiastic supporters. Work, however, was continued, and it was found, after repeated tests, that the bells used should have a lip or "sound bowl" several inches thick, and of a high musical note. The Submarine Signaling Company, of which Mr. Millet is vice-president and general manager, ultimately determined to build and operate a station. This necessitated a cable, a bell-buoy, in which a submarine bell was rung by wave motion, and a lightship, with a bell hung over the side at some depth below the keel; steam or compressed air furnished the power needed. A regular working system was established between Boston and New York, and a careful record kept. Permission was obtained from the United States Lighthouse Board to place submarine bells in four lightships that were moored in the course of steamers.

It was found that if the tanks were placed in vessels below the water line at certain fixed points aft, and at certain fixed points above the keel, and were filled with a solution denser than sea-water, the transmitters being adapted to the recognition of sounds of high pitch, and not those of low vibration, the submarine bell sounds, and other sounds, like screws of steamers, were readily heard, and the difficulty of "ship noise" was got over. It appeared, the author said, as if the noises made by machinery on board preferred to pass along the hull rather than turn to the lighter medium in the tanks; whereas transmitters fastened directly to the skin of the ship had invariably heard so much noise as to be useless for detecting outside signals.

With this apparatus, a number of successful results had been attained. The captain of one steamer at night directed his course to a lightship at a dangerous point on Nantucket shoals, when 5 miles away, in a heavy gale and snowstorm. He had heard nothing and seen nothing for five hours. His soundings indicated a lee shore. Under favourable circumstances the lightship syren might have been heard, but the gale carried its blast in the opposite direction. A tank was placed on each side of the ship, and by means of the connecting wires an observer was able to find out whether the bell sounds came from the port or from the starboard side. It was thus possible to find out on which side the signal was placed, and to steer a course accordingly. At first observation, as close as a quarter of a point had been recorded at a distance of 13 miles, and the screws of passing tugs or steamers made themselves heard. At the present time all the large trans-Atlantic and trans-Pacific steamship companies had examined and reported on the invention. The pilots of New York, Philadelphia and Boston, to the number of nearly 100, had added records of their personal tests. The Canadian Government had adopted the system. The Minister of Marine for Canada, together with his deputy and members of the Canadian Lighthouse Board, took steamer for Boston in order to test the invention; an experiment was made proving that sound could be sent from a tank on board a moving vessel to an observer on another moving vessel, even if the two were approaching each other at full speed. The tank was filled with sea-water,

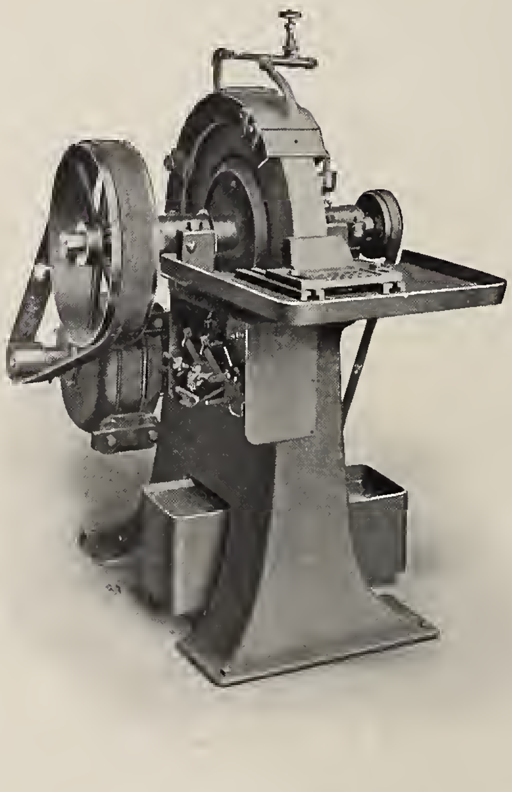


FIG. 34.—A 30-INCH SPRINGFIELD TOOL GRINDER, DRIVEN BY A 2-H. P. GENERAL ELECTRIC MOTOR. SEE PAGE 241

and a bell-weight of 140 pounds was hung in it, to be rung by hand. In the Canadian Minister's stateroom in the observing steamer an extra receiving-box was placed, connected to the transmitters by a special wire, and by using the apparatus the Minister, unassisted, correctly defined the position of the approaching steamer when it was $2\frac{1}{2}$ to 3 miles distant, both steamers making 14 knots. The author spoke of the untrustworthiness of air signals, a matter fully proved by the scientific investigations of the late Professor Tyndall. Reference was also made in the paper to the use of the apparatus for detecting the approach of submarine boats, and also for indicating to submarine boats the position of vessels to be attacked.

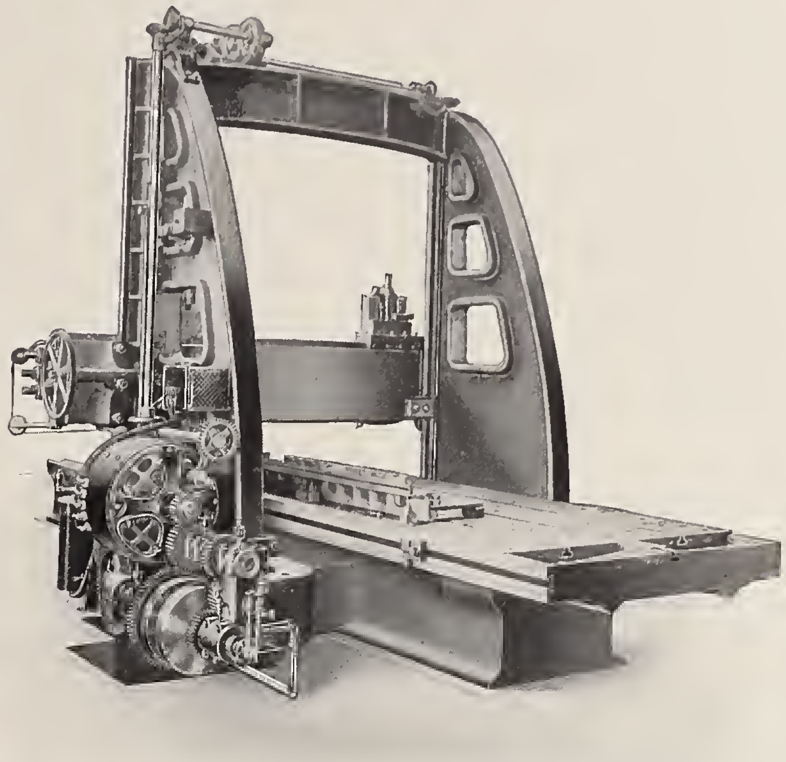


FIG. 35.—AN 84-INCH POND PLANER, DRIVEN BY A 15-H. P., 250-VOLT GENERAL ELECTRIC MOTOR. SEE PAGE 241

Methods for Increasing the Current Density in the Electrolytic Deposition of Copper

IN a recent paper before the British Faraday Society, Sherard Cowper-Coles classed the various processes for increasing the current densities in copper deposition by using mechanical means for keeping the copper smooth, as follows:—

1. Revolving or moving the cathode. The current density employed is comparatively low.
2. Burnishing the copper during deposition. The usual current density is under 20 amperes per square foot.
3. Insulating the growths on the copper so as to prevent further increase, as with the use of sheepskin and other impregnators. The current density is 35 to 40 amperes per square foot.
4. Rapid circulation of the electrolyte. Examples: Jets impinging on the surface of a rotating cylinder (current density, 50 to 100); the electrolyte discharging onto a flat cathode surface (current density, 300, just under the influence of the jets); spraying the solution on the cathode, the stream forming the only electrolytic connection. Impingement processes are not likely to be applied commercially until the amount of solution circulated can be greatly reduced.
5. Revolving a mandrel at a critical speed. This process was developed by the author. The mandrels are suspended vertically, and are provided with Pelton wheels driven by the electrolyte impinging against them. In the most recent form, however, a tubular vat is used, and hollow mandrels suspended on ball bearings, through the middle of which run the spindles. These are

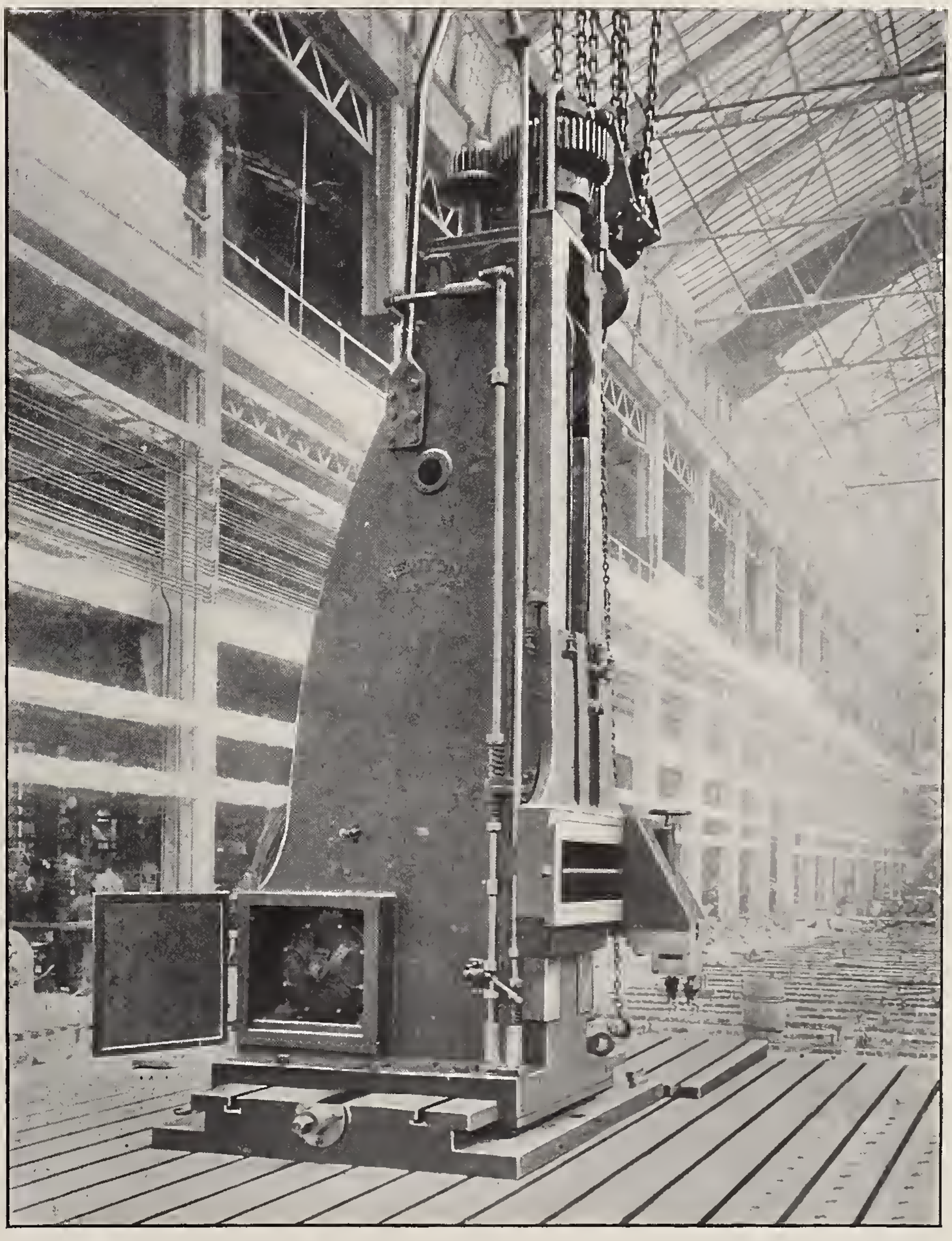


FIG. 36.—A VERTICAL PORTABLE PLANER OR SLOTTER. BUILT BY THE NEWTON MACHINE TOOL WORKS. THE WESTINGHOUSE INDUCTION MOTOR DRIVING THIS TOOL IS INSIDE THE HOLLOW COLUMN OF THE MACHINE. SEE PAGE 247

driven by a worm gearing from below. An 8-foot mandrel has to be driven only at about 50 revolutions per minute.

The copper is refined and manufactured into sheets or tubes in one operation, and is of a hard nature, similar to that which is cold-rolled; the process is at least ten times faster than any existing electrolytic process; a high current can be employed without deteriorating the quality of the copper; there is no risk of lamination; the plant is simple and free from mechanical complications; the amount of copper locked up for a given output is small, compared with other processes; finally, anodes of very impure copper can be used as compared to the anode copper used in other systems.

By using a mandrel in which a V groove has been indented, the spiral deposit that results can easily be pulled away, and then drawn down at once into wire, which can thus be made from crude copper in what is practically one operation.

Deadening Noise from Machinery

HAIR felt has repeatedly received mention as a means of deadening vibrations and noise from machinery, placed, for this purpose, between engine bed-plates and foundation capstones, and underneath rails subject to heavy train traffic.

Now, however, cork is said to have been used in Germany with the same end in view, the available particulars being to the effect that a sheet, made up of flat pieces of cork, in mosaic fashion, corresponding in size to the bed-plate of the noisy machine, and held together by an iron frame, is laid under the machine. What measure of success has been obtained with this new expedient is not told, though, as a means of temporary relief, it probably answered the intended purpose.

The true solution of most, if not all, machinery vibration problems is, however, to be found in proper foundations, ample in area and weight, and it generally pays to provide these if at all practicable. To what exercise of ingenuity the engineer is sometimes put in accomplishing this, was illustrated a dozen or more years ago in one large factory where, on an upper floor, a row of small engines had been installed for the independent driving of a corresponding number of different machines.

Though the building was of substantial construction, with steel floor beams, it was a foregone conclusion that that row of engines would cause trouble if set with nothing but the floor as foundation, and as it was undesirable to raise them much above the floor level, each engine was provided with a separate foundation, built up of brick and mortar in the usual way, but suspended by steel straps between the floor beams and thus projecting down into the head room of the floor below. Seen from there, each foundation, with its engine, appeared as if resting on airy nothing. But those suspended foundations accomplished all that was expected of them as vibration absorbers, and are, so far as is known, still doing good service.

Economy of Electric Motor Driving

THE relative economy of direct electric motor driving over the group system in textile mills has been given by M. H. Merrill in recently quoted figures from a large New England mill, in which a 200-H. P. motor operates 52 ring spinning frames. The cost of the motor was $2060, and of the belts and shafting $634, making a total of $2694. With direct connection fifty-two 3-H. P. motors would be required, at a cost of $5260, showing a difference in favour of group drive of $2566 so far as first cost is concerned. The interest on this sum at 5 per cent. is $128 per year.

Actual tests showed, however, that 37.5 H. P. was required to drive the shaft load alone with no frames in operation. The smaller efficiency of the small motors reduces this net difference to an equivalent of 18 H. P., which, at $25 per horse-power-year, gives $450 as the excess annual cost for power of the group system as compared with the individual. The net balance shows $322 per year in favour of the direct connected drive, this amount being the interest on $6440.

So much has been accomplished in recent years in utilizing waste products of all kinds that the unutilized waste heat in the exhaust gases of gas and oil engines has seemed a reproach to twentieth-century progress. Latterly, however, the idea of turning this carelessly abandoned energy to profitable account has received some attention, and at least one attempt has been made to apply it to steam raising. While the available particulars of the experiment are not very specific, they are at any rate indicative of work along a commendable line.

Edison's "Obvious" Inventions

ACCORDING to "Harper's Weekly," Edison recently made a suggestion by which a common failing of judges may be turned to account. The patent law demands that an invention shall show more evidences of imagination than are required in the ordinary makeshift improvements that are made every day in machine shops, and yet the simplest devices are the most effective and the most profitable. The Federal courts have several times invalidated Edison's patents on the ground that the improvements made by his devices were "obvious" solutions of the mechanical problems, and therefore not patentable. As in many problems that require hard study, the solutions did seem obvious enough—afterward.

Not long ago Edison was trying to work out a new piece of mechanism. It seemed a simple enough problem when he began it, but it proved to be extremely difficult. After several days' exasperatingly futile work, his attorney happened to ask him how it was coming along.

"No good yet," replied Edison. "But, of course, the thing is perfectly obvious. I wish you'd bring a committee of those Federal judges down here that are always saying that. If this thing is so almighty obvious, perhaps they can tell me how to make it."

The most interesting engineering event of the past month was the opening of a cantilever bridge across the Zambesi River, at Victoria Falls, in South Africa, on the line of the "Cape-to-Cairo" Railway. The bridge crosses the river at a height of a little over 400 feet and is altogether 650 feet long, the span of the arch measuring 500 feet. The gorge of the Zambesi which the bridge crosses is, in many respects, considered to excel the Niagara gorge in grandeur. The Zambesi above the Victoria Falls is about a mile wide, and the height of the falls ranges between 400 and 420 feet. When the river is in flood the volume of water going over the falls is estimated to be about double that at Niagara, representing about 35,000,000 H. P. going to waste.

Since the advent of the electrical sign in Boston, the amount of electrical current consumed has had such a notable yearly increase that Boston is said to now lead the world in consumption of electric current per capita,—that is, in the number of electric light units for each man, woman and child of her population.

Storage Batteries in Alternating-Current Plants

By H. S. KNOWLTON

THE storage battery has long been a familiar installation in direct-current power plants subjected to violent fluctuations of load. With a reputation for reliability of service and broad operating economy, based upon more than a decade of experience in central stations and railway plants, to say nothing of its myriad uses in telegraphy, telephony, automobile work, and other branches of applied electricity, it is needless at this time to point out the value of such equipment in the older fields of the industry. This value is, of course, determined for each specific engineering proposition with reference to both present conditions and past experience in similar cases.

It is only within the past two or three years that the storage battery has become useful in purely alternating-current plants. While this development has thus far proceeded upon a rather small scale, and appears likely to follow the same general course in the future, it is none the less important in its relation to the operating scheme of existing installations and the design of new stations.

Given a power plant without direct-current dynamos except exciters, the chief importance of a storage battery lies in its reserve power, not as an insurance against the interruption of service in case the engines, turbines, or main generating units break down, but as a protection from the failure of the exciters themselves. It is true that the exciters of an alternating-current plant seldom go wrong, and that they have long enjoyed an enviable reputation for steadiness. Probably an exciter is as reliable a piece of moving equipment as the average station contains. At the same time, the tendency of the best practice of to-day in the design of power plants is to leave no stone unturned to insure continuous service.

Engineers and operating men have, of course, realized the importance of an uninterrupted output from the earliest days of commercial operation, but it is safe to say that however great this importance has been in the past, to-day it is imperative, at least in the larger cities. In the days when a central station supplied street and residence lighting, a temporary interruption of the service during the daylight hours affected fewer consumers than such an event does to-day. Two reasons for this are apparent,—the increase in the number of customers, and the tremendous development of the motor load.

It is difficult to realize the cost of an interruption of service to the consumers, situated as they are at present. From the passenger in the tramcar hurrying to keep an appointment, to the manufacturer of a commodity which becomes ruined if the process is not continuous, it is no exaggeration to place the total expense of a five or ten-minute shut-down of power, up in the tens of thousands of dollars. From the dental office to the lecture hall one of the prime requisites of the commercial sale of current is a continuous supply. The patron of the theater, the pedestrian upon the lonely suburban street, the broker working overtime during a season of great market activity, the clergyman in the pulpit, the surgeon in the operating room at a crisis between life and death, the reader in the library,—all these and countless other human beings in the field of supply of a great power plant depend so vitally upon continuous service that an interruption is little short of a public calamity. To avoid such a contingency the modern designer exerts great energy, and the central station and railway manager is constantly on the alert to forestall trouble which may lead to a breakdown. Aside from the loss entailed upon consumers, the losses in gross receipts and suffering through critical public opinion which a shut-down plant sustains are always serious matters.

In attempting to bring about a design or operating methods which shall insure continuous service in alternating-current plants, the effort has been made to forestall possible ill-happenings and avoid having the operation of the entire plant depend upon a single piece of apparatus. Recent large power stations exemplify this idea in their equipment, as parallel and independent groups of coal compartments, boilers, pumps, engines, generators and switchboard panels are installed. This subdivision, however, is not usually carried as far as the exciters. In like manner the feed-water heaters are more or less combined, while the piping system depends upon first-class material and installation, with frequent separation, rather than upon duplication of equipment.

At first sight, the simplest and cheapest method of insuring against exciter breakdowns would seem to be the addition of one or two reserve machines, instead of the more expensive storage battery of equal capacity. This plan is, no doubt, satisfactory in cases where short shut-downs can be tolerated, as in small stations carrying very little motor load and extremely light loads in the daytime; but in a large station it means that the spare units must be run continuously if the alternator field current is to remain uninterrupted even if the regular exciters fail.

Here is where the exciter battery steps in automatically the instant an exciter breakdown occurs. The current supply is not interrupted for the slightest interval, and although the exciting voltage may fall perhaps 10 per cent. on account of the drop in the battery, it can quickly be brought to normal by the operation of the end-cell switch mechanism. End cells are usually employed to offset this voltage drop, due to continued discharge, although in some installations no regulation whatever has been provided, the fall of potential being taken care of by the alternator field rheostats. The battery at all times floats upon the exciter bus-bars, ready to take any emergency load that may fall upon it. A switch is usually provided for cutting out the battery in case it is necessary to work upon it. The end-cell switch may be operated either by hand or by a small motor with remote control, the latter practice being much in favour in large power houses.

There is at present very little uniformity in exciter battery practice, either as regards the capacity installed for given conditions, or the method of operation. In some cases the battery is not called upon for any regular service, but is held entirely in reserve against any sudden demand which it may be called upon to supply. In other instances the bat-

tery is used to carry a part of the increased load on the exciter due to the evening peak. Sometimes a battery is figured at a discharge allowance of double the hour rate, as when the entire demand of the alternator fields is thrown upon it. Again, a more prolonged discharge is often called for, and the capacity of the battery in such cases must be figured with reference to the length of time required to put the reserve exciters in service, in case they are installed.

An example of the application of an exciter battery to an alternating-current power plant may be cited for the purpose of showing the general method of procedure. Assuming four 3500-KW. alternators of the revolving-field type, the exciting current and regulation of each in a typical case may be tabulated as follows:—

EXCITING CURRENT AT 125 VOLTS.—AMPERES PER MACHINE AT VARIOUS LOADS

Power Factor	¼ Load	½ Load	¾ Load	Full Load	1¼ Load
100	175	180	190	200	220
90	185	205	230	250	285
80	190	210	240	265	300

REGULATION IN PER CENT. AT VARIOUS LOADS

Power Factor	¼ Load	½ Load	¾ Load	Full Load	1¼ Load
100	1	2.5	4.5	6	9
90	4	8	12	16	20
80	5	9	14	18	22

The machines in question have a voltage range of 2200 to 2400, 32 poles, a normal speed of 225 revolutions per minute, and generate 60-cycle, three-phase current. The exciters installed would probably be two in number, each being rated at 150-KW., so that either one could carry the entire excitation under the extreme conditions of 25 per cent. overload and 80 per cent. power factor. Incidentally, the efficiency of the alternators runs as follows:—

Load	¼ Load	½ Load	¾ Load	Full Load	1¼ Load
Per cent.	88	93.5	95.5	96.7	97

The stationary armature would weigh about 45,000 pounds; the revolving field, 44,000 pounds, and the total machine, 96,000 pounds, or 27.4 pounds per kilowatt. These figures do not, of course, all bear upon the excitation problem, but are given for their intrinsic interest. The striking feature of the excitation and regulation figures is the clearness with which they show the necessity of holding up the power factor under all conditions of load. Thus, the exciting current increases 50 per cent. between full load at 100 per cent. power factor and 25 per cent. overload at 80 per cent. power factor, the regulation meanwhile dropping from 6 to 22 per cent.

To provide liberally against breakdown, an exciter battery of 72 cells would probably be installed, having a discharge rate of about 800 amperes on the one-hour basis. At 2.4 volts per cell, the battery calls for a maximum of 175 volts when being charged with all the cells in series. If the exciters are capable of being driven at 40 per cent. above normal speed, one of them can readily be used to charge the battery. In case the exciters go out of service, the battery at once takes up the load, and if the alternators are not all in service, or are but partly loaded, the battery will easily carry the entire excitation for three or four hours or even more, during which time the exciters can be placed in working condition again unless the trouble is beyond the resources of the plant.

In the case of such a battery, probably 60 cells would be the average number connected across the bus-bars. The transfer of the exciter bus from one end-cell connection to another is effected without break or short circuit by the construction of the end-cell slider, which has two parts separated by a resistance, one or both of the adjacent end-cell switch connections being always covered. Such a battery installed would cost in the neighbourhood of $10,000, and as it would be but about 1 per cent. of the total cost of the plant, it would constitute an insurance of reasonable expense against interruptions.

Some examples of recent exciter battery installations are of interest as showing the conditions prevailing in practice. Two exciter batteries of the "chloride" type have been installed at the plants of the Edison Electric Illuminating Company, of Brooklyn. One of these is located at the Union station, and consists of 72 type "G 29" cells, made by the Electric Storage Battery Company, of Philadelphia, Pa. The one-hour discharge rate of these cells is 1120 amperes. There are 20 end-cells, the end-cell switch being motor driven. The battery is located in a small brick house adjoining the power station, the wiring and bus-bar connections being brought to the switchboard gallery located at the other end of the power plant. In addition to acting as a reserve for exciting the alternators, the battery supplies current when necessary for the operation of the station lights and for opening the alternating-current circuit breakers in the outgoing lines, as these are opened by direct current controlled by relays in the alternating-current circuits. These station lamps and breaker coils are supplied from the exciter bus-bars, across which the battery floats in parallel with the exciters, which are driven by synchronous motors.

The exciter voltage may be varied from 110 to 150, so that the battery can be charged once or twice a week. Each exciter is equipped with an underload circuit breaker which opens in case the load is lost through a reduction in the exciter speed, or failure in full field excitation. Otherwise the battery might discharge back through the exciter, causing it to run as a motor. There is no circuit breaker in the battery wiring, as the battery is required to take any load which momentarily may be thrown upon it.

Shortly after the battery was installed it was found that the current taken from the exciter bus varied from 800 to 1600 amperes during the day. This particular battery has frequently been called upon to take up the exciter bus load in case of emergency, and in other instances it has kept the exciters in service by holding them up to speed until the disturbance on the lines passed away. This feature of the exciter battery is most helpful, as steady excitation is an important factor in maintaining uniform voltage conditions on the premises of consumers. Relatively, this is more important in lighting plants than in railway power stations.

The other battery of the Brooklyn Edison Company consists of 72 cells of the "G 9" type, having a capacity of 320 ampere-hours on the one-hour basis of discharge. When this battery was installed, it supplied reserve power to an exciter bus to which two 75-KW. steam-driven exciters were connected, the alternators being four in number of 750-KW. each. The charging of the battery is done by a shunt-wound booster.

An exciter battery installed by the New York Edison Company was used not only as a reserve, but to take a considerable portion of the increased load on the exciter bus during the evening peak load of the plant.

The Boston Edison Company has installed within the past four or five months an exciter battery in its new L street station. It is located in a fire-proof battery house of concrete, adjoining the old L street plant, and consists of 82 cells having a one-hour rate of 1040 amperes. The bus-bars of the exciter circuit are carried in the form of copper strips into the battery house. The end-cell switches are located in a room just outside the battery room proper, which is drained and ventilated in the most approved style. Both hand and remote control are used, and the end-cell switch mechanism is equipped with electric indicators, which show the switchboard attendant the position of the

sliding contact at any time. The bus-bars are brought up vertically from the floor, alongside the wall, where they enter the end-cell switch room and are protected from accidental contact or short circuiting, by a wire screen. There are 19 end cells. The present equipment of the L street station includes four 1500-KW. alternators driven by vertical cross-compound engines, and two 5000-KW. turbo-alternators built by the General Electric Company, of Schenectady, N. Y.

The new Delray station of the Detroit Edison Company has an exciter battery of 82 cells, the discharge rate on the one-hour basis being 560 amperes. This station is designed for four 3000-KW., 60-cycle, 4600-volt, three-phase turbo-alternators as built by the General Electric Company; three of these sets are now installed. The exciter sets comprise two 75-KW. induction motor-driven units, and one 536-ampere steam-driven outfit located in the basement. The battery has two end-cell switches for regulation and simultaneous charging, and it is designed to supply the excitation required for one hour in case of emergency. It is charged from one of the exciters by raising the voltage on a special charging bus, while the second exciter carries the load.

The Metropolitan Street Railway Company, of Kansas City, also has an exciter battery in its station, consisting of 78 cells, having a one-hour discharge rate of 960 amperes. The tanks of this battery have a total capacity for the installation of enough plates to give an hourly discharge rate of 1200 amperes. When first installed, the capacity of this battery was but 480 amperes in plates, and it is worthy of note that the battery has been called upon to discharge at the rate of 1000 amperes for a few minutes in emergency cases, or at an overload of 108 per cent. above its normal one-hour rating. The battery at Kansas City is also called upon to carry a few lights in the station at night after the plant has shut down.

An exciter battery of smaller size is now in use at the plant of the Memphis, Tenn., Light & Power Company. It has a one-hour rating of 160 amperes and is charged from a shunt-wound motor-generator built by the General Electric Company, the generator giving 175 volts and 57 amperes, and the motor being wound for 500 volts.

The Interborough Rapid Transit Company, of New York, is shortly to install in its Fifty-Fourth street power house an exciter battery of 120 cells, having a one-hour discharge rate of 3000 amperes. This large battery will be charged from an induction, motor-driven, shunt-wound generator, and it will probably do some additional work in connection with the auxiliary apparatus in the station as well as floating on the exciter bus-bars. Exciter batteries are used for operating the remote-control switches in starting up a plant, no other power being available for this purpose. Among additional cities making use of exciter batteries, are Chicago, St. Louis and Des Moines.

In regard to closeness of regulation, this matter has been investigated several times with a view to determining whether it would be desirable to use a compound-wound booster in series with a battery in order to maintain the voltage when it is suddenly called upon to carry the load. Tests made by the New York Edison Company, and the Union Light & Power Company, of St. Louis, showed in each case that a regulating booster was not necessary. The drop in voltage due to the battery taking the load at the one-hour rate does not cause a serious disturbance of the voltage of the alternators, although a slight flicker of the lamps is to be expected. End-cell regulation is usually provided to take care of the further drop in voltage due to continued discharge. In several cases, however, no regulation has been provided except that produced by adjusting the alternator field rheostats.

It will be noted that thus far the representative installations of exciter batteries are principally in large plants, but there is every reason to believe that the appreciation of this means of insurance against breakdowns will become wider as time goes on, and as the loads on small plants grow more important. Great care is necessary in designing such installations to provide sufficient battery capacity in cases where the battery is to be used for other service than excitation. Otherwise, some day when the battery is suddenly needed, it will be found to be discharged. A point to be recalled in this connection is the low maintenance expense which should be a feature of the battery's operation, tending to offset its first cost in comparison with dynamo exciters of equal capacity. The service is not usually severe, in comparison with regular railway and lighting work.

An Electric Cooking Demonstration in a Central Station

It is encouraging to note that during the past year a good deal of energetic interest has been taken in electric heating and cooking by electric central stations everywhere. Evidence of this is given by the appointment of heating committees by the National Electric Light Association as well as the Association of Edison Illuminating Companies, the former having presented a report on the subject at its Denver convention last summer, and the latter at the recent convention at Lake Champlain.

These reports were based on replies to questions propounded to numerous central stations, and the general trend of the answers seemed to indicate an increasing interest in electric heating apparatus, and an inclination to make more active investigations and exploitations of its usefulness and value as an income producer.

The committees, furthermore, were inclined to be quite enthusiastic over the opportunity for the sale of electricity for heating purposes, and the sale of electric heating apparatus, provided an intelligent canvass of the field were made. They urged, furthermore, the desirability, from a general advertising standpoint, of making complete cooking demonstrations.

It is of particular interest, therefore, to note that besides preaching this doctrine, the Philadelphia Edison Company has deemed it expedient to practice it as well, and believing that the soliciting of heating business should be done by men who have familiarized themselves thoroughly with what has been done and what can be done economically, they arranged recently for a practical demonstration and lecture to its district managers and solicitors.

A demonstrating table and kitchen equipment were set up in the assembly room of one of the sub-stations and invitations were issued to the officials and soliciting forces of the various districts. Max Loewenthal, E. E., an electric heating expert, was requested to deliver the lecture and he was assisted by Miss Helen Tovell, who prepared the following tempting menu by means of the electric devices:—

AN ELECTRIC COOKING DEMONSTRATION BY MR. MAX LOEWENTHAL AND MISS HELEN TOVELL

Soup
Cream of Tomato

Relishes
Olives Celery

Poultry
Roast Squab with Euchered Figs

Roast
Broiled Steak
Cauliflower au Gratin Potato Chateau

Cake
Apple Helene
Coffee Tea

Mr. Loewenthal, in his introductory remarks pointed out the causes which seem to be responsible for the comparatively limited introduction of electric heating and cooking devices, such as the scarcity of well-informed canvassers to preach the electric heating gospel and the resultant ignorance of the utility of such devices on the part of the public. Then, too, there are the question of cost of current and prices of apparatus to be considered, and their mechanical construction and thermal efficiency and small number of wired residences in the larger cities. These last would be augmented by the desire of householders to use small electric heating and cooking devices as soon as they were made conversant with their many advantages.

The lecturer then, by means of experiments and a display of articles showing the various systems in use in this country and Europe, familiarized his hearers with the history and present status of the industry, pointing out the advantages and disadvantages of the different systems. Finally suggestions were made as to the best manner in which to solicit electric heating business from householders, as well as industrial establishments. Wherever localized heat is required, up to, say, 750 degrees, F., electricity should supplant gas and steam in factories, on account of its cleanliness and safety, its effect on the sanitary conditions of the establishment, which, in turn, means the production of a greater amount of,

and superior, work, the absence of pipes and offensive odours, and, above all, the localization of the heat at the place where it is wanted.

The limitations of the application of the devices under discussion was next taken up and the lecturer advised strongly against soliciting the installation of room heaters and electric kitchens, unless current is sold for about 2.5 cents per KW.-hour, at which figure it compares favourably with gas at $1.00 per 1000 cubic feet, assuming electric heating apparatus to have an efficiency of about 80 per cent., and gas apparatus from 20 to 30 per cent.

A lively discussion followed Mr. Loewenthal's interesting talk, during which many valuable points were brought out. Among those taking part in the discussion were Messrs. Elgin, Israel, Maxwell, Spillman and Myers.

During the lecture Miss Tovell prepared the meal referred to above, and careful meter readings were taken to determine the consumption of current for the preparation of each dish, for use of the soliciting department.

After flashlight photographs of this interesting scene had been taken,—they are here reproduced by the way,—and a vote of thanks had been tendered to the lecturer, the meal which had been prepared was served to a large number of those present, and it was almost midnight when the lights were extinguished.

The first electric tramway built in Japan was the line, 8 miles in length, which was opened in Kyoto in 1895. Since then, other cities of importance have built electric tramways, and there are now 17 companies with an aggregate capital of 36,000,000 yen ($18,000,000), whose lines already opened aggregate 120 miles, with 85 miles more building.

Testing Rubber Insulated Wire

THE Wire Inspection Bureau affiliated to the Underwriters' Laboratories, of Chicago and New York, recently held a conference for the purpose of devising ways and means of testing all rubber-insulated wire manufactured under the rules of the National Board of Fire Underwriters, and to prevent the introduction into commercial use of any such wire which would prove inferior to the standard demanded by the National Board of Fire Underwriters. It was decided to appoint electrical inspectors, three being considered sufficient at present, who shall from time to time visit the testing laboratories of any factories making rubber-insulated wire, and make, supervise, and verify tests specified by the bureau. The expenses of these inspectors are to be paid by fees collected from the manufacturing companies whose product is tested.

LECTURING ON ELECTRIC COOKING BEFORE REPRESENTATIVES OF THE PHILADELPHIA EDISON COMPANY

Artificial Illumination—V

By DR. EDWIN JAMES HOUSTON

Continued from the September Number

APPARATUS FOR DIRECT AND INDIRECT ILLUMINATION

TWO of perhaps the most important devices manufactured under Westinghouse control for both direct and indirect illumination, are a variety of incandescent electric lamp known as the Nernst lamp, and a variety of lamp known as the Cooper Hewitt mercury vapour lamp.

The Nernst lamp, now made by the Nernst Lamp Company, of Pittsburg, was invented in 1898 by Dr. Walther Nernst, of Goettingen, Germany. This lamp depends for its operation on the fundamental principle that the oxides of certain rare metallic earths possess the power of conducting electricity only after being raised to a certain high temperature by the application of external heat. In other words, the substances employed for this purpose are practically non-conductors at ordinary temperatures. When such conductors are heated, the electric current begins to pass through their mass, and thus increasing their temperature, permits a greater and greater proportion of current to pass, until in a few moments sufficient current passes to raise the mass to a high temperature of incandescence.

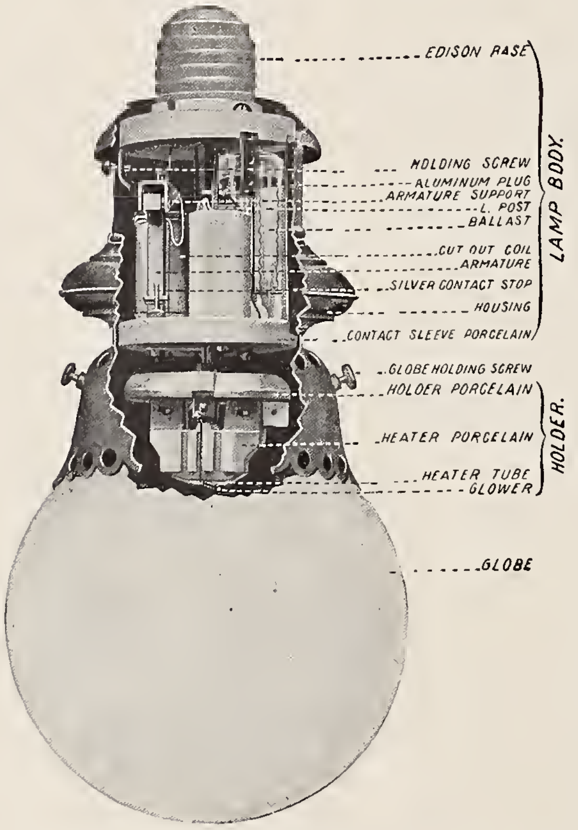


FIG. I.—A ONE-GLOWER NERNST LAMP MADE BY THE NERNST LAMP COMPANY, PITTSBURG, PA.

The Nernst lamp is a variety of filament incandescent electric lamp, like the carbon filament lamp, but is unlike this lamp in that it requires its filament to be raised to a certain temperature before the electric current can act on it. It is evident, therefore, that the Nernst lamp is necessarily more complicated in construction than the ordinary filament lamp. Consequently, unless the Nernst lamp possessed marked advantages over the ordinary incandescent lamp, it would not be possible for it to successfully compete with the ordinary filament lamp in actual practice. As we shall see, however, certain advantages are claimed for the Nernst lamp that would appear to make it a formidable rival of the carbon filament lamp. These advantages will be referred to as soon as the peculiarities of the construction and operation of the Nernst lamp have been more thoroughly explained.

As is well known, in the carbon incandescent electric lamp, the lamp consists of a slender carbon filament suitably connected to platinum leading-in wires, and placed inside a lamp chamber, from which, as nearly as possible, all the air has been removed. When properly constructed, the carbon incandescent lamp is a marvel of simplicity, consisting as it does of only a filament with its leading-in wires and enclosing lamp chamber, together with a lamp socket for the reception of the lamp proper.

In the early history of the Nernst lamp, the necessary heating of the glower was obtained by means of an alcohol lamp, or even by the application of the flame of a lighted match. Such lamps, however, were not successful in practice, as they were not provided with the necessary starting resistance or ballast. In the automatic Nernst lamp, as now constructed, the number of parts are necessarily greater than in the ordinary carbon incandescent lamp. The practical Nernst lamp consists of the following parts:—

1. A glower, or short filament, formed of oxides of certain rare metallic earths.

2. A device, called the heater, employed for the automatic heating of the glower so as to render it a conductor of electricity.

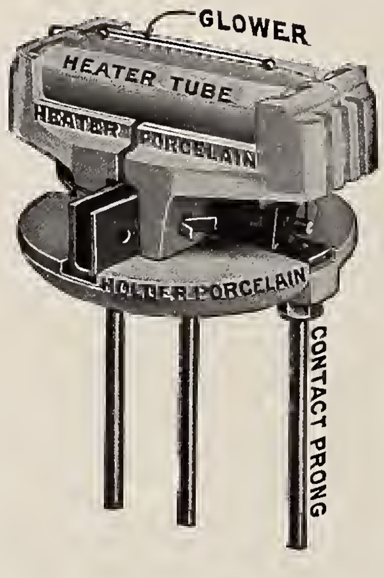


FIG. 2.—PARTS OF THE NERNST LAMP HOLDER

3. An automatic cut-out, by means of which, as soon as the current passing through the heater coil has raised the temperature of the glower to a point at which it is capable of taking sufficient current to render it incandescent, and consequently a source of artificial light, the current is automatically cut off from the heater coil and permitted to pass only through the glower.

4. A device, called the starting resistance or ballast, consisting of an iron wire that is employed for the purpose of preventing any damage to the glower from a sudden increase in its electrical conducting power due to its increase in temperature.

The arrangement of these different parts is represented in Fig. 1, which shows the construction of a 1-glower Nernst lamp. Fig. 2 represents the various parts of the lamp holder, with the names of the parts marked on. The position of the heater tubes as regards the glower is clearly indicated. Here the glowers are placed above the heater wires. For all 1, 2,

or 3-glower Nernst lamps, there are two heater tubes connected in series, as represented in Fig. 3.

For all 6-glower lamps, there are four heater tubes connected in parallel series, as represented in Fig. 4. As will be seen from an inspection of this figure, where the heater tubes are connected in parallel, the wires are simply twisted together.

FIG. 3.—HEATER TUBE CONNECTIONS FOR THE ONE, TWO OR THREE-GLOWER NERNST LAMP

The electric connections of the various parts of the Nernst lamp are represented in Fig. 5. Here, as will be seen, the glower is placed in series with the main line and with the steadying resistance or ballast and the automatic cut-out coil. The heater is placed in shunt with the main-line terminals, as shown.

The operation of the Nernst lamp is as follows:—When the switch is turned on the Nernst lamp, the current has a path through both the heater coil and the glower, ballast, and cut-out coil. Owing, however, to the peculiar nature of the substance of which the glower is made, practically no current is able to pass through it or the parts connected in series with it. All the current passes through the heater coil, which is raised practically instantaneously to the temperature of a white heat. Owing to the neighbourhood of the glower to the heater coil, the temperature of the glower is rapidly raised, so that the electric current begins to pass through its mass. As the temperature rapidly increases, a stronger and stronger current successively flows through the glower, the destruction of the glower being prevented by the peculiar action of the ballast or steadying resistance,

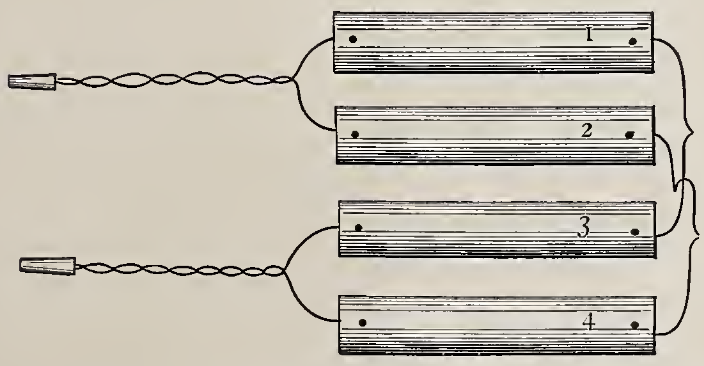


FIG. 4.—HEATER TUBE CONNECTIONS FOR THE SIX-GLOWER NERNST LAMP

which will be explained shortly. As soon as the current strength through the glower reaches a certain critical point, that corresponding to the temperature at which the current is capable of causing its incandescence, the current strength through the coil of the automatic cut-out becomes sufficient to automatically result in the attraction of its armature, thus cutting the heater coil out of the circuit, and keeping it cut out as long as the current continues to pass through the glower. When, however, the lamp is turned off by the key provided for this purpose, the current ceases to flow through the cut-out coil, thus permitting its armature to fall back again into its place. In this manner the heater coil is ready for again starting the lamp when the key is turned on.

Fig. 6 represents in graphic form the variations that take place in the current strength on the turning on of the current through the heater coil of the Nernst lamp. The gradual increase of the current through the glower and the automatic cutting out of the current from the heater coil, as soon as a certain increase in the current strength has been reached, is represented in the curve in the figure. Here the numbers on the left-hand side of the figure represent the current in amperes, and at the bottom of the figure, the time in seconds. The curve is taken from an automatic 6-glower lamp, that is, a Nernst lamp provided with six separate glowers. This lamp requires for its operation a current of about 2.4 amperes. As will be seen from an inspection of the curve, maximum current of about 3 amperes first passes through the heater coil. For the first 25 seconds the current strength is as represented in the figure, when the glower begins to take current. At the end of about 31 seconds, the automatic cut-out coil cuts off the current from the heater, the current now being limited to the glower. The glower current reaches its maximum strength at the end of about 40 seconds, when the gradual depression in the curve from this time on is a result of the action of the lamp body and ballast, while attaining their normal running temperatures. Having in this manner pointed out the general construction and operation of the Nernst lamp, let us inquire more particularly into the construction and operation of its several parts.

Taking up first the construction of the glower, it should be remarked that this portion of the Nernst lamp resembles the filament of the ordinary carbon incandescent lamp, except that it is much shorter and thicker.

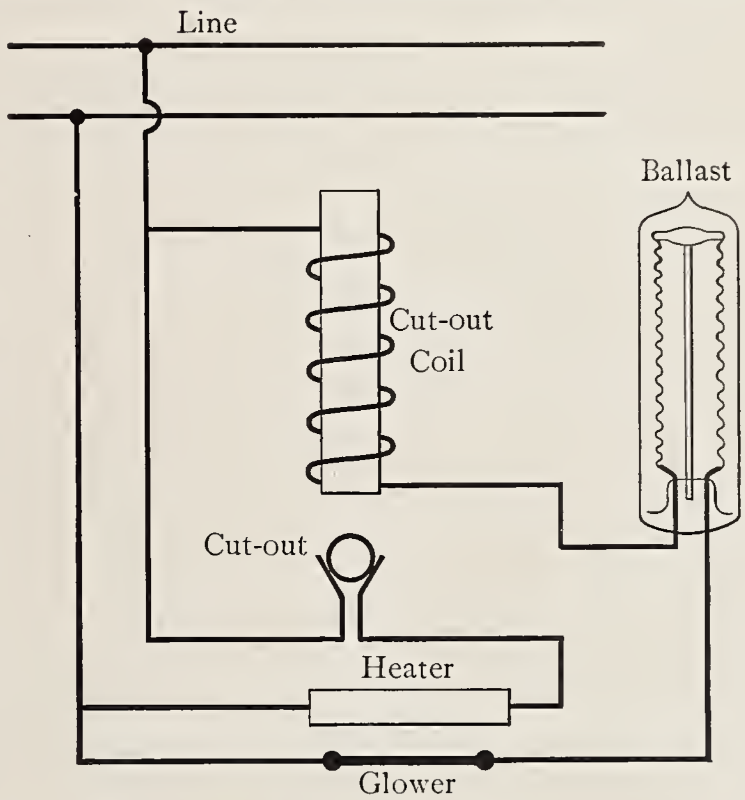


FIG. 5.—DIAGRAM OF CONNECTIONS OF THE ONE-GLOWER NERNST LAMP

The glower is produced by pressing a mixture of the oxides of certain metals of the rare earths through a die, the oxides being first mixed into a plastic dough with a suitable binding material. After this mass has been passed by pressure through a die, it is dried and cut into suitable lengths and then subjected to a baking process after the terminals have been attached to the ends of the mass for the ready passage of the current that is required to raise it to the temperature of incandescence.

The glower of a 220-volt Nernst lamp is about 1 inch in length and 1-32 of an inch in diameter.

A difficulty existed in the early history of the Nernst lamp in obtaining suitable terminal connections between the ends of the glower and the incandescent electric mains. The arrangement first made by Dr. Nernst consisted in wrapping a few turns of

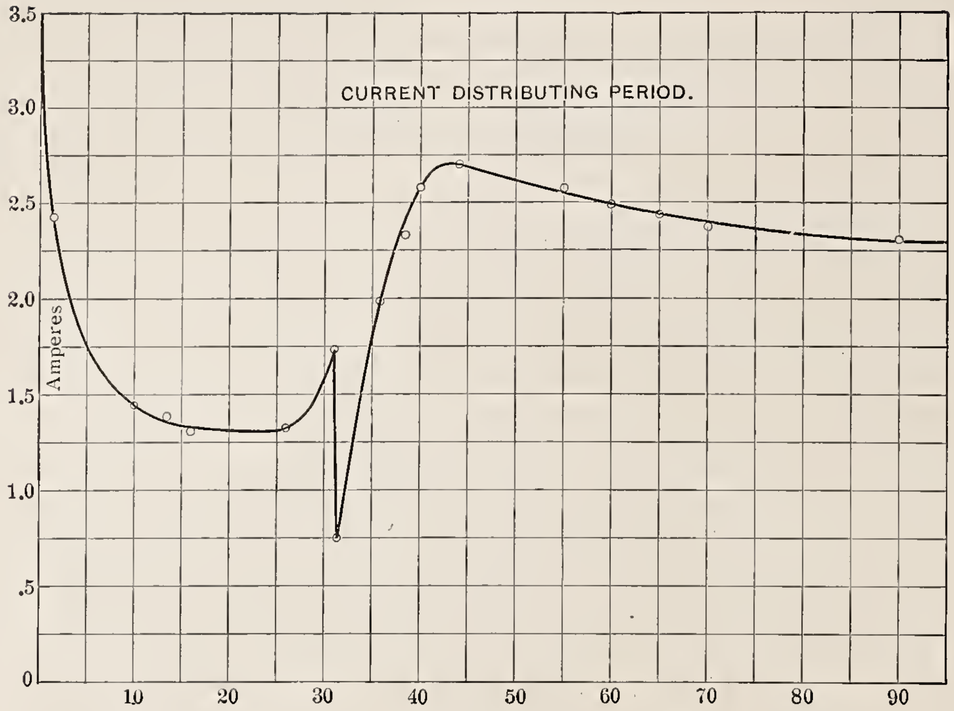


FIG. 6.—CURVE SHOWING THE VARIATIONS IN THE CURRENT REQUIRED BY A SIX-GLOWER NERNST LAMP

platinum wire around the ends of the glower, the connection being finally pasted with a suitable cement. In this form of connection the shrinkage of the glower ends resulted in their tearing away from the platinum wires, thus causing an inefficient action of tne current and the final destruction of the lamp. At the pres-

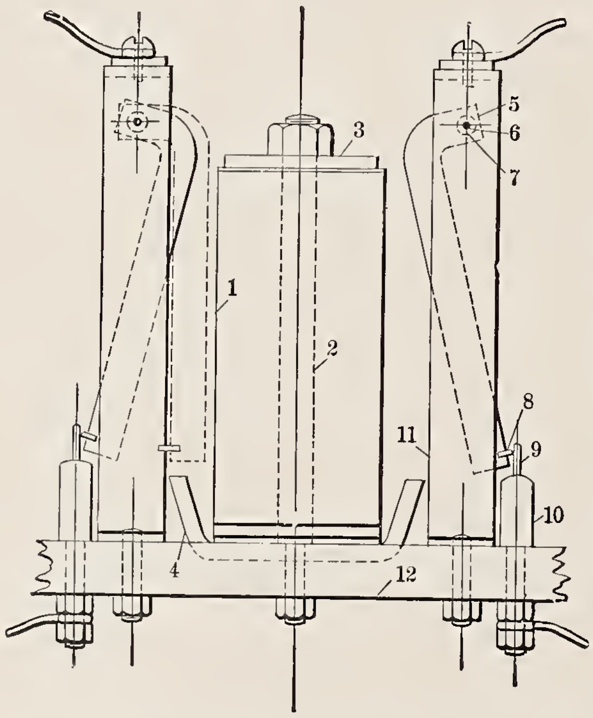


FIG. 7.—FORM OF CUT-OUT COIL USED IN THE NERNST LAMP

ent time the terminal connections are made by imbedding a platinum bead at each of the ends of the glower in such a manner as to cause, on the shrinkage of the glower material, a tighter binding of the terminals to the glower, thus insuring a contact that is maintained in efficient action between the platinum bead and the glower.

The following advantages are claimed for the Nernst lamp, owing to the peculiar character of the glower and the manner in which it is operated:—

1. No enclosing glass globe is necessary, as in the case of the carbon filament lamp. Since the materials of which the glower is constructed consist of oxides, the glower is necessarily incapable of further oxidation. It is, therefore, possible to operate the lamp in the open air. Indeed, the result of actual trials appears to show that the presence of oxygen is necessary for the proper operation of the filament.

2. The character of the glower is such that it is possible to raise its temperature to a much higher degree than that of the carbon incandescent filament. A much higher efficiency of operation is, therefore, claimed for this lamp than is possible in the case of the carbon filament lamp; for example, it has been claimed that the Nernst lamp is capable of giving about twice the amount of light for the same amount of current as does the ordinary carbon incandescent lamp.

3. The higher temperature of operation of the glower results in the production of a light the colour of which much more closely resembles ordinary sunlight than does the light from an ordinary incandescent lamp.

4. The light produced by the Nernst lamp is steadier than that of the ordinary incandescent lamp, and there are not the pulsations in voltage that are characteristic of the carbon lamp. This necessarily results from the fact that while in the case of the carbon incandescent lamp an increase in voltage results by the corresponding increase in the current, in increased temperature, with a consequent increase in the amount of light, in the case of the Nernst lamp the action of the steading resistance or ballast prevents any marked increase in the temperature of the glower, thus resulting in a more uniform intensity of the light produced; in other words, the operation of the Nernst lamp at an overload permits the expenditure of energy to take place largely in the steadying resistance or ballast, so that a comparatively small increase occurs in the candle-power of the glower. It is claimed for the Nernst lamp that when operated continuously at an overload of 5 per cent., the candle-power of the glower is increased only 14 per cent., while the life is not sensibly decreased. Under these conditions, as is well known, in the case of the carbon incandescent lamp the candle-power would be increased 40 per cent., while the life would be decreased some 60 per cent.

It is claimed that these advantages are more than sufficient to compensate for the increased complexity of construction and operation of the Nernst lamp over that of the ordinary incandescent carbon filament lamp.

Coming now to the construction and operation of the steadying resistance or ballast, as it is also called, the presence of this device is necessary in the case of the Nernst lamp owing to the fact that as the electric current passing through the glower increases in strength, the voltage across its terminals rises, at first rapidly, and then more slowly, to a maximum, when it drops off with increasing rapidity as the current strength through the glower and the temperature of the glower increase.

FIG. 8.—ONE FORM OF INDOOR NERNST LAMP OF THE SIX-GLOWER TYPE

Beyond the point of maximum voltage, the rapid decrease in the resistance of the glower makes the current exceedingly difficult to control, so that were there no steadying resist-

FIG. 9.—AN INDOOR NERNST LAMP OF THE SIX-GLOWER TYPE

ance or ballast, this rapid increase in the current strength would necessarily result in the destruction of the glower.

The steadying resistance or ballast consists of an iron wire that is placed in series with the glower and the automatic cut-out coil. Iron is especially suitable for this purpose, since it possesses the property of rapidly increasing its resistance with an increase in temperature, especially in reaching what is called its critical resistance. While this property is also possessed by practically all metals, yet iron possesses it in a more marked degree, thus rendering it particularly suitable for employment as a steadying resistance.

In order that the iron-wire ballast or steadying resistance shall be able to operate so as to immediately check the passage of a momentary rush of current, it must possess a small heat capacity. For this reason the diameter of the wire should be small, and the wire should be placed in such condition as will permit it to rapidly lose its heat. Since very fine iron wire employed in the ballast resistance would readily be destroyed by oxidation on exposure to the air, it is necessary to place the wire inside a glass tube from which all the air has been removed. At the same time, however, in order to permit the heated wire to rapidly dissipate its heat, this space is afterwards filled with some inoxidizable substance, like nitrogen gas.

The iron wire employed as a ballast for the Nernst lamp has a diameter of 0.045 mm. or less than 0.002 of an inch, that is, of smaller diameter than ordinary human hair. A ballast of this design is known as a 0.4-ampere ballast.

While the Nernst lamp glower might readily be controlled by the use of a sufficiently large steadying resistance that possessed no particular temperature correction, yet such a resistance would necessarily decrease the net efficiency of the lamp, since the resistance necessary under high voltages would, of course, be present under normal conditions of working.

The glower employed in the Nernst lamp becomes a good electric conductor at a temperature of 600 degrees C. (1112 degrees F.) to 700 degrees C. (1292 degrees F.). This temperature is readily obtained by the use of a heater, the construction and operation of which will now be described.

The heater employed in the Nernst lamp consists of a thin porcelain tube that has platinum wire wound over its surface. This wire is held in place to the tube and protected from the destructive action of the intense heat of the glower by covering it with a suitable refractory paste. While the use of platinum for this purpose necessarily increases the cost of the lamp, yet since the platinum undergoes practically no injury by its use in the lamp, and possesses in red lamps a value of nearly 90 per cent. its original cost, the objections to its use lack significance. According to Wurts, the heater of a Nernst lamp has a life, when running continuously, of about 200 hours, or 133 hours when the current is turned on or off 4000 times at regular intervals. Since the heater is in service only about 30 seconds for each lighting of the glower, this would very greatly extend the life of the heater.

One form of cut-out coil is represented in Fig. 7. This consists of an iron core *2*, an iron washer *3* placed at the top of the coil, and an iron yoke *4* that forms the pole-piece of an electromagnet. This electromagnet is provided with an armature *5*, supported as shown on a silver pin *6*, that is provided with a silver bushing *7*. The electric current passes through the post that supports the armature, to the pin *6*, the bushing *7*, the armature *5*, and through the armature to the movable contact *8*, and thence to the fixed contact *9*. As soon as the strength of the current passing through the glower reaches the point that is necessary for the proper operation of the lamp, the current passing through the coil of the electromagnet results in the attraction of its armature 5, thus cutting the heater out of circuit and keeping it cut out as long as the current continues to pass through the glower. When, however, the lamp is turned off by the turning of a switch, this current, ceasing to pass through the coils of the electromagnet, permits its armature to fall back into its place, thus leaving it ready for operating the heater when the switch of the lamp is again turned.

Nernst lamps are made in sizes from the 55-watt lamp whose light equals a 25-candle-power incandescent electric lamp, to the 6-glower lamp, whose light is equal to that of the 5-ampere enclosed arc lamp. They are made suitable for street lighting or for indoor lighting. Some of the different forms of lamps employed for indoor lighting are represented in Figs. 8, 9 and 10. Figs. 8 and 9 show two different forms of Nernst indoor 6-glower lamps. These lamps have a length of $15\frac{1}{2}$ inches and a weight of $5\frac{1}{2}$ pounds. Fig. 10 represents a form of Nernst 6-glower lamp especially suitable for alternating-current circuits. In the upper part of the figure is shown a converter coil. This coil can be made to operate the following different combinations of lamps:—One 6-glower lamp; six 1-glower lamps; three 2-glower lamps, and two 3-glower lamps. This lamp takes 110 volts at 5 amperes. Its length is $20\frac{3}{4}$ inches and its weight $21\frac{1}{2}$ pounds.

The Nernst 4-glower indoor lamp

FIG. 10.—ANOTHER INDOOR NERNST LAMP OF THE SIX-GLOWER TYPE WITH CONVERTER COIL

is suitable for 110 volts at 5 amperes, and is capable of taking an alternating current of any frequency from 50 to 133 cycles.

Nernst lamps are constructed so as to be operated at two different voltages; in other words, there are two types of lamps, one known as the 110-volt type, arranged so as to be adjustable for any voltage from 100 to 120 volts, and the other known as the 220-volt type, capable of being adjusted for any voltage from 200 to 240 volts. In these lamps the voltage is regulated entirely by means of the glower; in other words, the heater tubes and ballast resistance remain the same in a given type of lamp. The glowers intended for one size of lamp are not interchangeable with the other sizes of lamps of the same voltage. For instance, a glower that is suitable for a 220-volt single-glower lamp should not be placed in a 6-glower lamp, although operated on the same circuit.

In the following table are given the interchangeable glowers. From this it will be seen that all 0.4-ampere alternating-current glowers for lamps of the 220-volt type are interchangeable among the 1, 2, 3, or 6-glower lamps, as indicated in the table of voltages; for example, a glower for a 210-volt 6-glower lamp may be employed in a 212-volt 3-glower lamp, in a 220-volt 2-glower lamp, or in a 226-volt single-glower lamp. It will also be seen from the table that all glowers for 6-glower lamps between 200 and 234 volts can be used in either 3, 2, or 1-glower lamps of different voltages.

TABLE OF INTERCHANGEABLE GLOWERS

Voltage of Lamps			
6 Glower	3 Glower	2 Glower	1 Glower
			200
			202
			204
		200	206
		202	208
		204	210
		206	212
	200	208	214
200	202	210	216
202	204	212	218
204	206	214	220
206	208	216	222
208	210	218	224
210	212	220	226
212	214	222	228
214	216	224	230
216	218	226	232
218	220	228	234
220	222	230	236
222	224	232	238
224	226	234	240
226	228	236	
228	230	238	
230	232	240	
232	234		
234	236		
236	238		
238	240		
240			

FIG. 11.—THE UNION SAVINGS BANK, PITTSBURG, LIGHTED BY NERNST LAMPS

The Nernst lamp has been successfully employed at Sewickley, Pa., for street lighting. The installment in this town, which is situated near Pittsburg, Pa., consists of 96 6-glower lamps of the outdoor type. These lamps are provided with clear 8-inch globes. The electric plant consists of three alternators of 60, 90 and 90-KW. capacity each, built by the Westinghouse Electric & Manufacturing Company, of Pittsburg. The 60-KW. unit produces a single-phase alternating current of 16,000 alternations at a pressure of 1100 volts. This current is transmitted to transformers, the capacity of which varies from 1 to $7\frac{1}{2}$ KW. Here the

FIG. 12.—THE FIRST CHURCH OF CHRIST, SCIENTIST, PITTSBURG, LIGHTED BY NERNST LAMPS

current is stepped-down to 220 volts. For street lighting by Nernst lamps, the distance between successive lamps ranges from 150 feet in the business districts to 800 feet in the outlying districts.

The steady character of the light produced by the Nernst lamp, together with its near approach to ordinary daylight lighting values, renders this lamp especially suitable for the lighting of such interiors as churches, office buildings, department stores, etc. Fig. 12 represents the application of this system of illumination to the lighting of the First Church of Christ, Scientist, at Pittsburg, Pa. As will be seen, the lamps are placed at a considerable distance above the floor space, thus thoroughly protecting the eyes of the worshipers from the glare of the light. Fig. 11 represents the application of the Nernst lamp to the lighting of the Union Savings Bank, of Pittsburg, Pa.

FIG. 13.—A COOPER HEWITT LAMP WITH REFLECTOR

THE COOPER HEWITT MERCURY VAPOUR LAMP

This lamp is the invention of a Dr. Peter Cooper Hewitt, of New York. It consists of a glass tube provided with wires hermetically sealed into the ends of the tube. This tube is provided with electrodes, either one or both of which consist of metallic mercury.

The Cooper Hewitt lamp depends for its operation on the passage of an electric current through a mass of mercury vapour contained in a glass lamp tube. The tube is first connected to a vacuum pump, and when a high vacuum has been obtained, is hermetically sealed, thus thoroughly preventing the escape of the mercury vapour which fills the tube.

In order to start the lamp, the tube is tilted, thus permitting the mercury to flow from one electrode to the other in a fine stream. This stream momentarily connects the two electrodes. As it breaks into globules, the current is continued through the mercury vapour which is thus raised to a high incandescence.

It is a well known fact that the light efficiency produced by any incandescent lamp increases very rapidly with the temperature. In lamps the filaments of which consist of solid substances, the limiting temperature is that at which the substance volatilizes or fuses. As we have seen, one of the advantages claimed for the Nernst lamp lies in the fact that the temperature of the filament of metallic oxides can safely be raised to a much higher temperature than is possible to safely raise the temperature of a carbon filament. In the case of the Cooper Hewitt mercury vapour lamp, there is practically no limited temperature to which it is safe to raise the mercury vapour, since already being a vapour it cannot be injured by a higher temperature. For this reason the efficiency of the mercury vapour lamp is much higher than that of ordinary lamps. This will be evident from an inspection of the following table, taken from an article by Professor Geer, in the "Physical Review" for February, 1903:—

	Per Cent
Illuminating gas, Argand burner	1.61
Incandescent electric light	6.00
Electric arc light	10.04
Acetylene	10.50
Geissler tubes	32.00
Mercury vapour lamps	40.90 to 47.90

As will be seen, the efficiency of the Cooper Hewitt lamp is higher than that of any other artificial illuminant. Incandescent electric lamps require from 3 to 4 watts of current per candle-power. The open arc electric lights require about 1½ watts per candle-power, while the enclosed electric arcs require 2 watts per candle-power. Contrasted with this is the fact that, as is claimed for the Cooper Hewitt lamp, it requires the expenditure of but ½ a watt per spherical candle-power. In other words, a 700-candle-power mercury vapour lamp requires no more current than a cluster of three 32-candle-power incandescent lamps. It is claimed, moreover, as the result of actual practice, that the Cooper Hewitt lamp possesses at least twice the efficiency of the arc lamp, and from six to seven times the efficiency of the incandescent electric lamp.

Contrasted with this high efficiency, however, is the unfortunate fact that the Cooper Hewitt lamp gives a light of a bluish-green tinge, in which the red rays are conspicuously absent. It cannot, therefore, be employed for any use in which colours require to be distinguished. Its use intensifies the blue and the green, imparts to yellow colours a greenish tint, and causes red to appear black or purple. Black and white, however, are not affected. The use of this lamp, therefore, has been successful in the case of draughting rooms and similar places, since it is capable of bringing

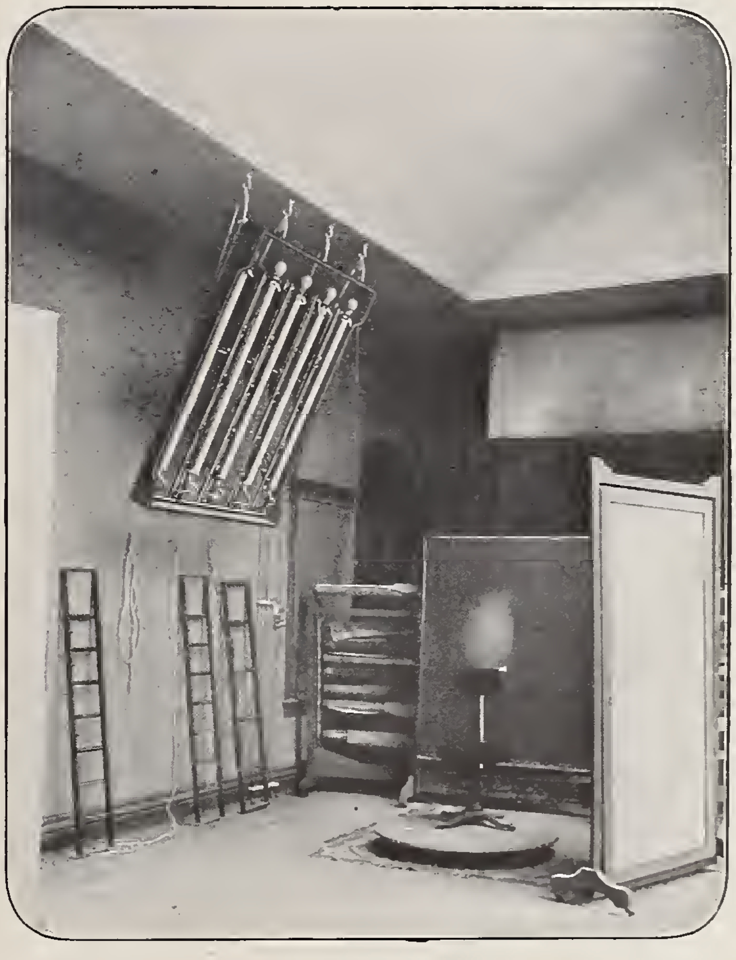


FIG. 14.—A STUDIO EQUIPPED WITH FIVE COOPER HEWITT MERCURY VAPOUR LAMPS

out black and white in sharp contrast with each other.

Since the Cooper Hewitt lamp is produced by a heated mass of mercury vapour of considerable dimensions, it is capable of affording an illumination of marked uniformity. It is, moreover, a steady light, not being subject to the fluctuations of the arc light.

The lamp is generally made in the form of a glass tube 1 inch in diameter, and of a length varying according to the voltage it is desired to employ on the lamp. For general illumination, these lamps range in length from 18 to 45 inches. Fig. 13 shows the general appearance of a Cooper Hewitt lamp. The chain attached at one end of the lamp is provided for starting the lamp by tilting.

Since the lamp contains an excess of the shorter wave lengths of light, it is especially suitable for photographic purposes. It is claimed that a Cooper Hewitt lamp consuming 7 amperes of current can produce satisfactory exposures in the same time as would be required for two arc lamps consuming 25 amperes of current, or, in other words, that the efficiency of the mercury vapour lamp for photographic purposes is about 3½ times that of the arc lamp. Fig. 14 shows the arrangement of five Cooper Hewitt mercury vapour lamps in a studio to take the place of the ordinary skylight.

It is claimed that the average life of this lamp is about 1000 hours, and that lamps have been employed for 2000 hours, showing but a slight decrease of candle-power. This contrasts favourably with the average life of the incandescent lamp, which is generally under 600 hours.

Cooper Hewitt lamps require direct current for their operation, and are constructed to operate singly on commercial direct-lighting circuits at pressures of from 50 to 150 volts. On constant-current circuits of higher voltage, the lamps are arranged to be operated in series. All of these lamps operate at from 3 to 3½ amperes.

The scaling up of water pipes and jackets is quite as likely to happen as that of boilers. Water jackets on gas-engine cylinders are known in many instances to have become thoroughly clogged with mud and scale, with overheating as the result, and only recently a case was recorded where a boiler feed pipe had to be taken down and cleaned out before the feed pump could be made to run at its old-time speed.

Unnecessary Refinement in Boiler Setting

In a discussion, some time ago, before one of the engineering societies, of different methods of setting steam boilers of the horizontal, cylindrical kind, the point was well made that a good deal of unnecessary refinement often enters into the setting of boilers of any type. One instance brought to notice was that of a horizontal boiler in which the rear end, according to specification, had to be supported on hardened and ground balls, and the V guides or seats for them had to be made of steel or iron, planed and finished all over and case-hardened. While the man who drew up the specifications considered it necessary to make such refined provision for the lengthwise expansion of the boiler,—the distance between the centers of the front and the rear brackets being only 13 feet, —he lost sight entirely of expansion sidewise. No provision whatever was made for this. From center to center of the ball supports crosswise of the boiler the distance was 8 feet, so that there was almost two-thirds the expansion sidewise that there was longitudinally, and it seemed odd, indeed, that anyone who would go to so much trouble over the lengthwise expansion would forget all about possible trouble in the other direction.

Electric Light from Rubbish in New York City

For economically disposing of the rubbish collected from house to house, a combined rubbish incinerator and electric lighting plant has recently been built in the city of New York. The incinerator proper belongs to the Department of Street Cleaning, and the electric lighting plant to the Department of Bridges.

All the refuse collected from householders in the city must be separated into three classes,—ashes, garbage, and rubbish, before it will be taken away by the collecting carts. In other words, no mixed refuse is accepted. Of this refuse, only that which comes under the head of rubbish will be utilized in the new plant, but street sweepings of a combustible nature such as are not of value as a fertilizer will also be used.

The rubbish collected consists of wooden boxes, waste paper, cardboard, rags, matting, old pieces of furniture, old bedding, etc. Up to the present time this rubbish has been disposed of by dumping it on low ground. Among the disadvantages of the old method may be mentioned the heavy expense attached, the undesirable nature of the material for filling on account of the length of time necessary for it to settle, the nuisance created by rats to which it gives shelter, and the danger of fire.

In the new rubbish incinerator and electric. lighting plant, the heat produced by the burning of the rubbish is to be utilized to generate steam for electric light service for the Williamsburg Bridge and probably for a number of school houses and parks in the vicinity.

The street carts that bring the rubbish to the plant will drive up an incline on the outside of the building at the rear onto a fireproof platform, and there deposit their loads. The material will be pushed by hand into hoppers, and from there led into the cells of the furnaces. The incinerator has a capacity of 300 cartloads of 7 cubic yards each, per day of 24 hours, and it is claimed that this amount of rubbish will be more than enough to operate the 400-H. P. installation of boilers.

At this rate the yearly capacity of the new plant will be about 50,000 tons, if operated continuously at full load, and as there are now about 100,000 tons of rubbish in Manhattan and the Bronx to be disposed of each year, it is very probable that if this plant satisfactorily meets the demands made upon it, other similar plants will be built in other parts of Greater New York.

There are every year in this country thousands of needless accidents in mines, in factories, and on railroads that fill our courts with damage suits aggregating millions of dollars. While some of these suits are dismissed, the cost of defending them in the courts is an important item. It therefore follows that, as a matter of investment, every employer of labour should encourage co-operation to increase the use of safety devices.

The copper mines of Lake Superior are making more metal, employing more men and, with the exception of one period, earning larger net profits than ever before in their history. At the time copper was selling at 19 cents a pound, in the spring and early summer of 1899, the monthly earnings probably were a trifle greater than at present, but the price then obtained was abnormal and was maintained at an even lower level only by manipulation, ending in a disastrous break in prices, while the present metal market is a natural one, and the price of copper, while a trifle higher than the more conservative producers desire, is caused by a strictly legitimate demand.

Explosions from Straying Railway Currents

By A. A. KNUDSON

THE destruction by electrolysis of underground metal pipes, which, as is well known, has been going on for years, is by no means the limit of damage of which the vagrant trolley current is capable. The ruin of water and gas mains is bad enough, but the causes of such damage can be traced out, the currents identified, and the responsibility for removing them placed where it belongs. Reimbursement also can be obtained for damage found.

Cases of ignition of gases or other combustibles, however, by the sparks from trolley currents, the author believes to be but little understood generally, and on this account they have not been given the importance they would seem to deserve by those having combustibles on their premises. The object of this communication is to call attention to what is believed to be a real danger, and to point out how explosions from such ignition occur and the methods of prevention.

It is commonly known that a very small electric spark will cause ignition of combustibles. As a practical example we have but to conveniently push a button or pull a pendant in many homes to light the gas.

Where a building happens to be located between a line or lines of an electric railway on the one side and the power house feeding such lines on the other side, and such establishment is supplied by the usual water and gas pipes, there is opportunity for railway currents to enter it by way of these pipes, attracted by outlets to "grounds" or other reasons, and prove a menace to the building in case combustibles are manufactured or carried on the premises.

By way of illustration, an instance of this kind will be given which was recently brought up for examination.

The works in question were located, in respect to trolley tracks and power house, as just outlined, or in other words, were in line with returning railway currents and not far from the tracks. The conditions inside the works were as follows:—

An acetylene gas plant was used upon the premises to supply light. Sparks amounting to flashes of fire at times would appear in different parts of the works between metals touching water, gas, or steam pipes. One case was in the office where the swinging arm of a gas fixture could be made to touch the riser of a steam pipe. Touching and separating the two metals would produce a snapping spark,—at times amounting to a flash.

Figs. 1 and 2 will give an idea of the conditions. While sparks would

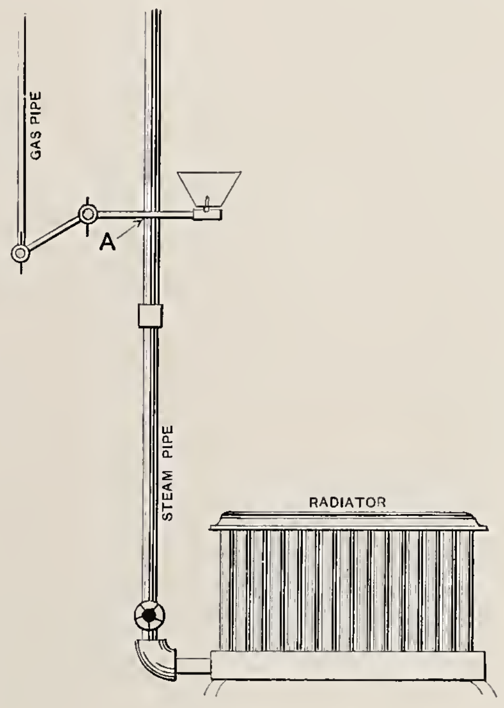


FIG. 1

occur at *A*, in Fig. 1, they would also occur at *B, C, D* or *E,* in Fig. 2. In the latter case, a gas and water main were near together against the wall in the fire room, and any metallic connection between the two, such as a bundle of wire, an iron bar, or other tools placed against them loosely, would cause sparks. The proprietors were much worried by these sparks as they feared an explosion which might destroy the works. They had no idea of the cause of the sparks or how they could be removed.

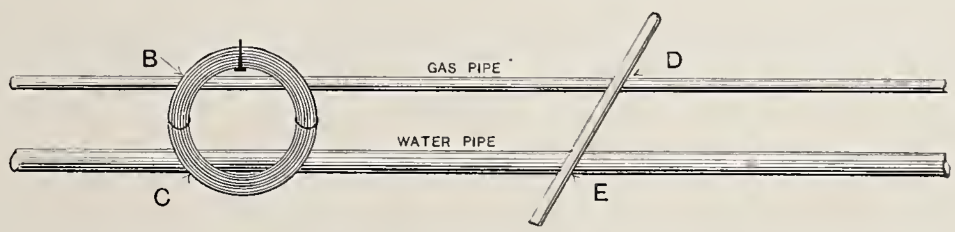


FIG. 2

Examination disclosed quite a high difference of potential between the two systems of pipes,—gas and water, or gas and steam. The gas main entering the building, however, was not at this time supplying gas. The currents finally were traced to where the mains entered the works. At this point, as a measure of immediate protection, they were bonded together under the writer's direction with copper wire. This effectually shut off any further entrance of trolley current into the works, and no further sparks could be found, much to the relief of those in charge.

This case illustrates one condition only. Other cases of even greater importance with entirely different conditions have been traced out, requiring different treatment. In works where there are combustibles, trolley currents are all the more dangerous because, being silent and unseen, they may not even be suspected until after an explosion has taken place; then it may be very difficult to prove the cause of the explosion.

In the course of one examination a current flow of from 5 to 20 amperes was found passing into large oil works upon the pipe which supplied the works with water. The men in charge stated that recently two explosions had occurred in the works, causing much loss, and they "could find no earthly reason for either of them." It is quite possible that both explosions may have been caused by this trolley current, found to be flowing along the water pipe into their works. The proposed remedy for such a case is to install insulated joints in the main.

It is deemed imperative as a measure of safety, that works connected with the usual gas and water or other pipes, where explosives are manufactured or carried in any quantities, should be examined to ascertain if any currents are entering such works on these pipes, even if a trolley road

or power house is a mile or more distant. In the case of powder works or powder magazines this statement would particularly apply, especially if pipes of any kind enter such works.

Ordinary precaution would, therefore, suggest that frequent tests be made at all works carrying explosives, and upon pipe lines entering such works by someone experienced in such matters to determine if electric currents are present, and if so, to suggest and install such remedy as will be effective under the existing conditions. This is a danger which is not mythical, but real, and a matter of interest to fire underwriters as well as to those more directly concerned.

Before the Denver (Col.) Ad. Club, recently, George E. Turner said in regard to electric signs:—"Outside of the big advertisers the people in the East are the same as they are in Denver. They want to get too many words in a given space. An electric sign, or any other sign, should be boiled down to the fewest possible words. There are two good ways of getting up an electric sign. One is to have it large and the letters plain and distinct; no flashing on and off, but to be quietly read with the fewest possible words you can use to keep yourself before the people. The other way is to have some 'moving' feature in your sign that the people will be interested in."

A French Portable Electric Plant for Track Laying and Repairing

THROUGH the courtesy of A. Collet, of Paris, we are enabled to reproduce here several illustrations of a portable electric plant of his design, for permanent way construction and repair, and in use at present on several French railways.

The various tools are electrically driven, the current being generated by a dynamo coupled to a steam engine, the whole forming the set shown. A steam engine has been preferred to a petrol motor, seeing that it is capable of a wide range of speed and power without loss of efficiency, and also on account of the high cost of petrol in France.

The steam is supplied to the engine at 176 pounds pressure by a vertical tubular boiler, resting on a strong frame together with the other parts of the machinery and a water tank. The coal required is carried in a separate truck.

The engine is vertical compound non-condensing, developing 25 H. P., and is coupled to the dynamo by a belt provided with a tightening pulley. The current is continuous, at a pressure of 220 volts. The whole generating set weighs but 3.3 tons empty; it measures 6 feet 5 inches in height, 8 feet 6 inches in length, and 6 feet 3 inches in width. It can be carried by road or rail, and contains, as will be seen by reference to the illustrations, a pair of main wheels, made with a wide, flat rim, for transport on common roads, and at each corner a pair of small flanged wheels for running on tracks. The latter wheels are made to turn on vertical pivots; the axle carrying the central road wheels can be raised or lowered by acting on a hand-wheel and toothed-wheel gearing, which operate a vertical screw, the nut of which, on being shifted, effects the raising or lowering of the axle. When the generating set is run on rails, the road wheels are, as a rule, set for carrying it together with the small end wheels (Fig. 3). For placing the set as in Figs. 1 and 2, it is raised on the road wheels, the end wheels are turned round, and when they are level with the side track, loose rail lengths are placed underneath them on balks, and the set is driven on the side track. While this is proceeding, the men in charge string the current supply and return wires along the line of railway on which work is to be done. These wires are carried on folding ladders, each ladder being provided with about 150 feet of wire, together with insulators. (See Figs. 4, 5 and 6.)

Current is collected and supplied to

FIG. 1.—A VIEW OF THE COLLET PORTABLE POWER PLANT AND OF THE SCREW SETTING MACHINES. TWO OF THESE LATTER ARE CARRIED ON A SMALL TRUCK

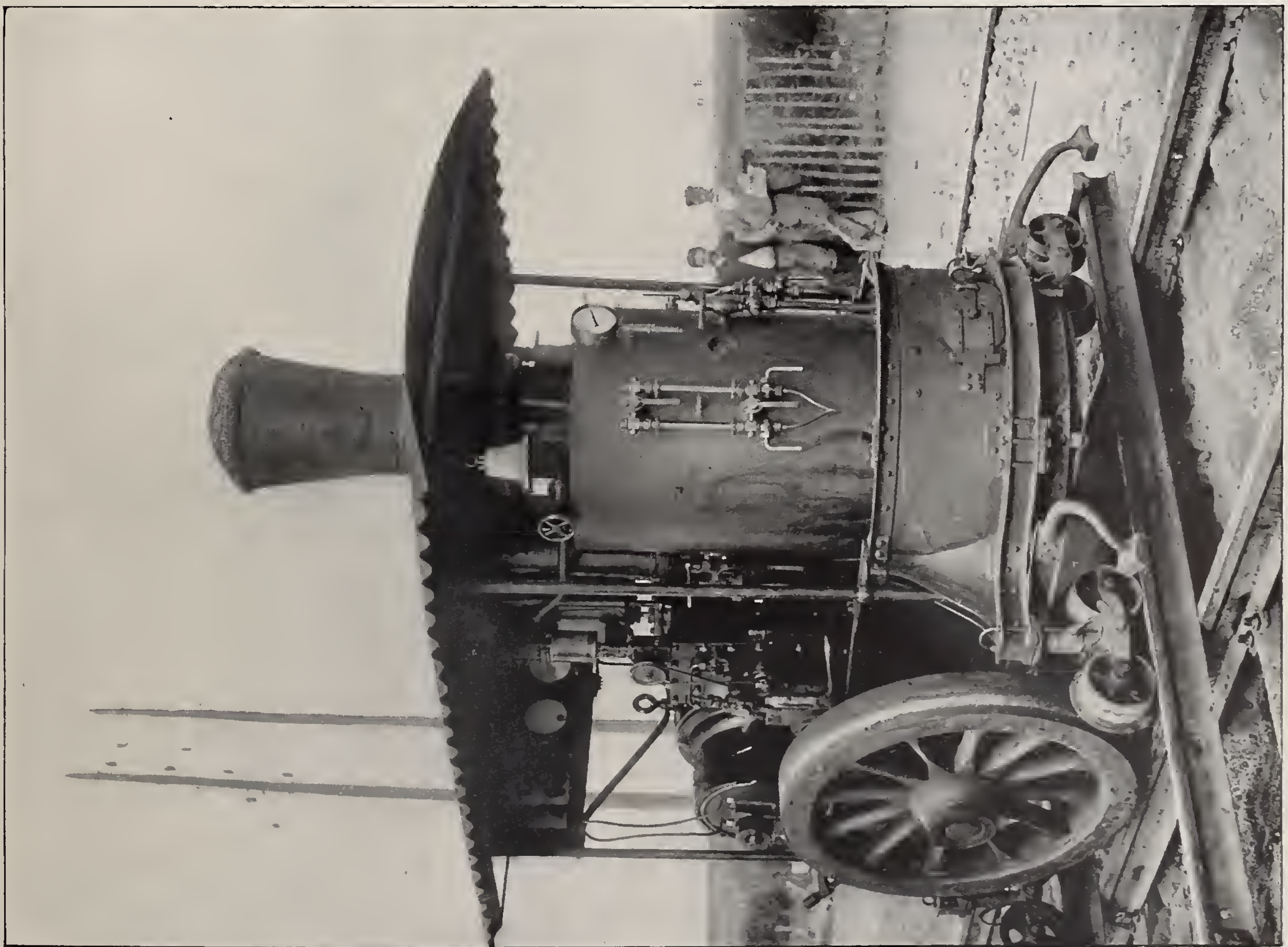


FIG. 2.—THE PORTABLE POWER PLANT READY TO RUN OFF ON A SIDE TRACK

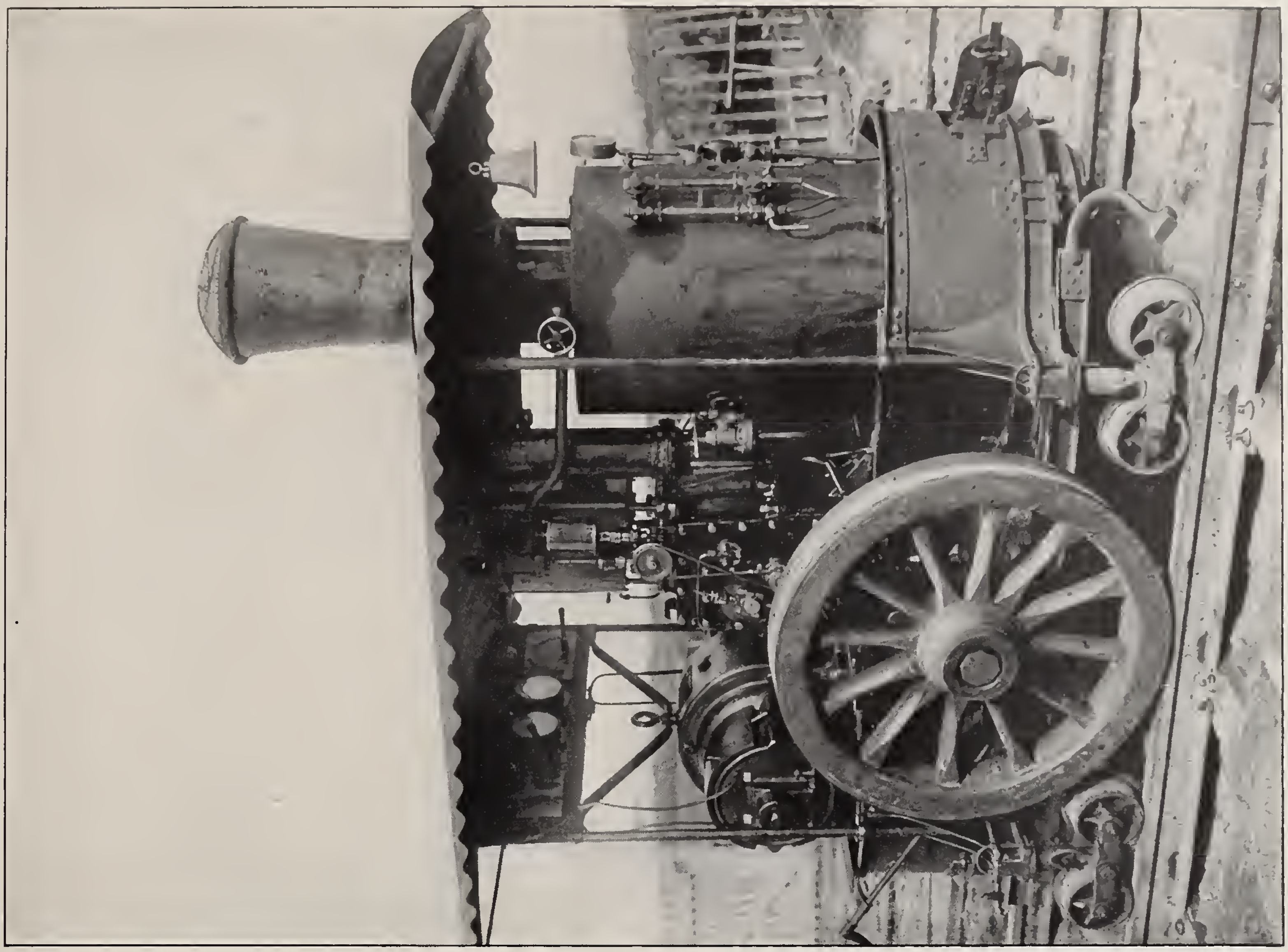


FIG. 3.—THE OUTFIT RUNNING ON THE MAIN LINE

COLLET'S PORTABLE ELECTRIC PLANT FOR TRACK LAYING AND REPAIRING

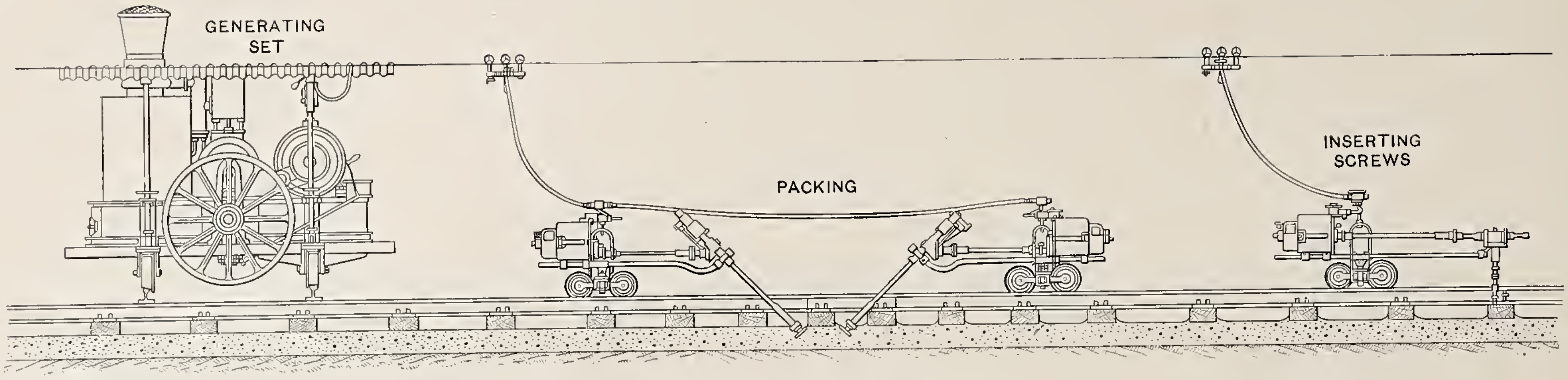


FIG. 4.—AN ELEVATION OF THE WHOLE OUTFIT, COMPRISING PORTABLE POWER PLANT, SCREW SETTING AND TAMPING MACHINES, AND ELECTRIC TRANSMISSION LINE

the tools by small trolleys fitted with a handle and three rollers which run on two wires. The screw setting and unscrewing machine, shown in the cuts, is driven by a small electric motor which turns around a vertical pivot and drives a horizontal shaft by a universal joint; the outer end of the shaft is provided with a similar joint, to which is connected an extension fitted with two pinions. The latter gear in a horizontal toothed ring keyed on the vertical shaft of the screw-setting tool.

Two such machines are carried on a small truck as shown in the illustrations, though one alone can be made to work on both sides of a line. With four men—two to work the machines, and two to hold the sleepers by means of crowbars—the two machines can set the 200 screws of about 60 feet of single track in 10 minutes, —about seven times faster than by hand.

The tamping tools are connected to an electric motor by a shaft and universal joints similar to those which drive the screw-setting machines. They are also mounted in pairs on the same truck. The packing tools are inclined, as shown in Fig. 4. They are in two parts; the lower is fitted with a head and is driven by the upper, which acts as a hammer. This upper part bears at its top end against a spiral spring, the release of which insures the required shock, the spring being compressed after each blow by the action of a cam on the horizontal shaft driven by the motor. A buffer device allows the packing tool to work, as occasionally happens, under no resistance, without risk to the device. The tool gives 400 strokes per minute. The time necessary to completely pack a sleeper in broken stone is 1 minute, with six men,—four at the tools, the other two providing the ballast. In sand the time taken is about 35 seconds.

The small trucks carrying the screw setting and packing tools are easily removed; the dynamos and tools attached are first carried from the pivot on which are placed the former, and the truck, which weighs only about 45 pounds, is then lifted off. In most cases a telephone signal is given to the man in charge of a plant by the lookout man; in others, telephone connections are established between the plant and the nearest railway station.

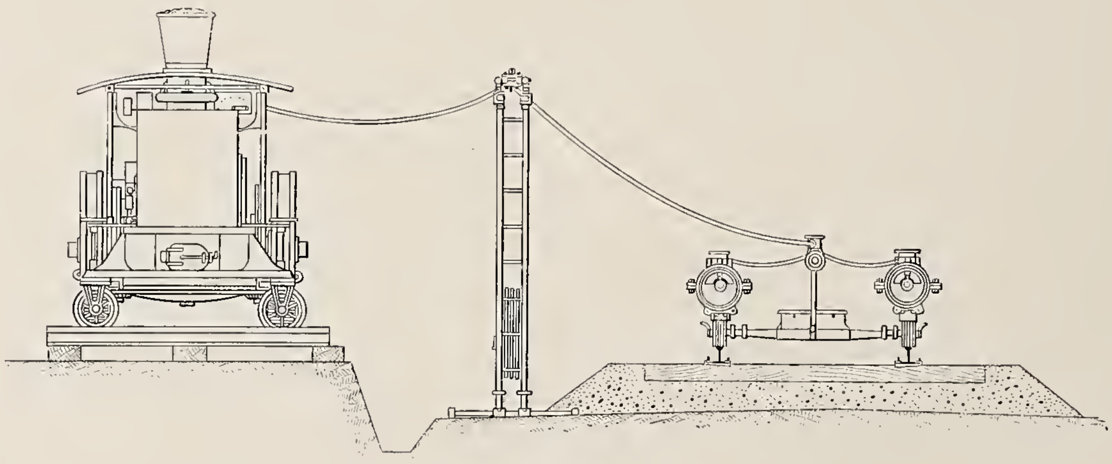


FIG. 5.—AN END VIEW

Mr. Collet's apparatus has been adopted by the French Compagnie du Nord, the Compagnie de l'Est, and the Paris, Lyons & Mediterranean road, besides the principal lines in Spain. The Paris-Lyons-Mediterranean Railway Company have made a five-years' agreement for the maintenance of a section of their main line with a contractor using the appliance.

More recently Mr. Collet has supplemented his plant with a drilling auxiliary which still further extends its usefulness.

The production of aluminium in the United States has increased nearly tenfold in as many years, according to the recently completed annual report of the United States Geological Survey for 1904. Two reasons explain this phenomenal growth—economic production, which has initiated low prices, and increased consumption, especially in the electrical industry. The output of 1904 was 8,600,000 pounds.

Raising the Level of the Great Lakes

THE International Waterways Commission spent September 13 and 14 in making an inspection of the scenic and industrial features of Niagara Falls and that locality, and in hearing representatives of power and other interests. According to "The Iron Age," this was deemed the most important meeting of the commission, and it received much attention from the several engineers who are connected with the development of power on both sides of the river, as well as from the Commissioners of the New York State Reservation and the Commissioners of Victoria Park, the latter on the Canadian side. While no plan for raising the lake levels has been adopted, it has been understood that this commission would investigate the advisability of erecting a dam and sluices at the outlet of Lake Erie near Buffalo, and this suggestion, made some years ago, served to arouse all the Niagara interests.

The American members of the commission are Col. O. H. Ernst, George Y. Wisner and George Clinton, while the Canadian commissioners are Louis Coste, John P. Mabee and W. F. King. Louis C. Sabin is the secretary of the American board, and Thomas Cote of the Canadian board. Col. Ernst, as chairman of the meeting, read the act of Congress that authorized the appointment of

the commission by the President. Among those present at the meeting were Commissioners Potter and Porter and Superintendent Edward H. Perry, of the New York State Reservation; Commissioner George H. Wilkes and Superintendent James Wilson, of Victoria Park; Attorney Lovelace, Superintendent P. P. Barton, Resident Engineer Van Cleve, Third Vice-President De Lancey Rankine, of the Niagara Falls Power Company, Mr. Van Cleve being also the resident engineer of the Canadian Niagara Power Company; Arthur Schoellkopf and Chief Engineer John L. Harper, of the Niagara Falls Hydraulic Power & Manufacturing Company; Patrick F. King, representing the Niagara, Lockport & Ontario Power Company, the Lower River & Water Supply Company and the International Power & Transmission Company; Banker R. Payne and Attorney Fred W. Hill, representing the Ontario Power Company; Beverley F. Value, engineer of the Electrical Development Company of Ontario, Ltd.; Mayor O. W. Cutler, representing the commercial interests of Niagara Falls.

Col. Ernst first called on Mayor Cutler, who asked that the commission carefully consider the importance of the upper river navigation to the future of Niagara Falls, and that no obstruction to navigation be placed in the stream.

Commissioner A. K. Potter, of the New York State Reservation, asked as a citizen and as an official of New York State that the falls of Niagara be preserved. He argued that the Niagara River is not only a national boundary, but it is in contemplation of law, throughout its entire length, a navigable stream.

Commissioner Potter also presented a resolution adopted by the Commissioners of the State Reservation at Niagara Falls, requesting the International Waterways Commissions to urge upon their respective governments the necessity of preventing the further diversion of the waters of Niagara River from their natural course over the falls.

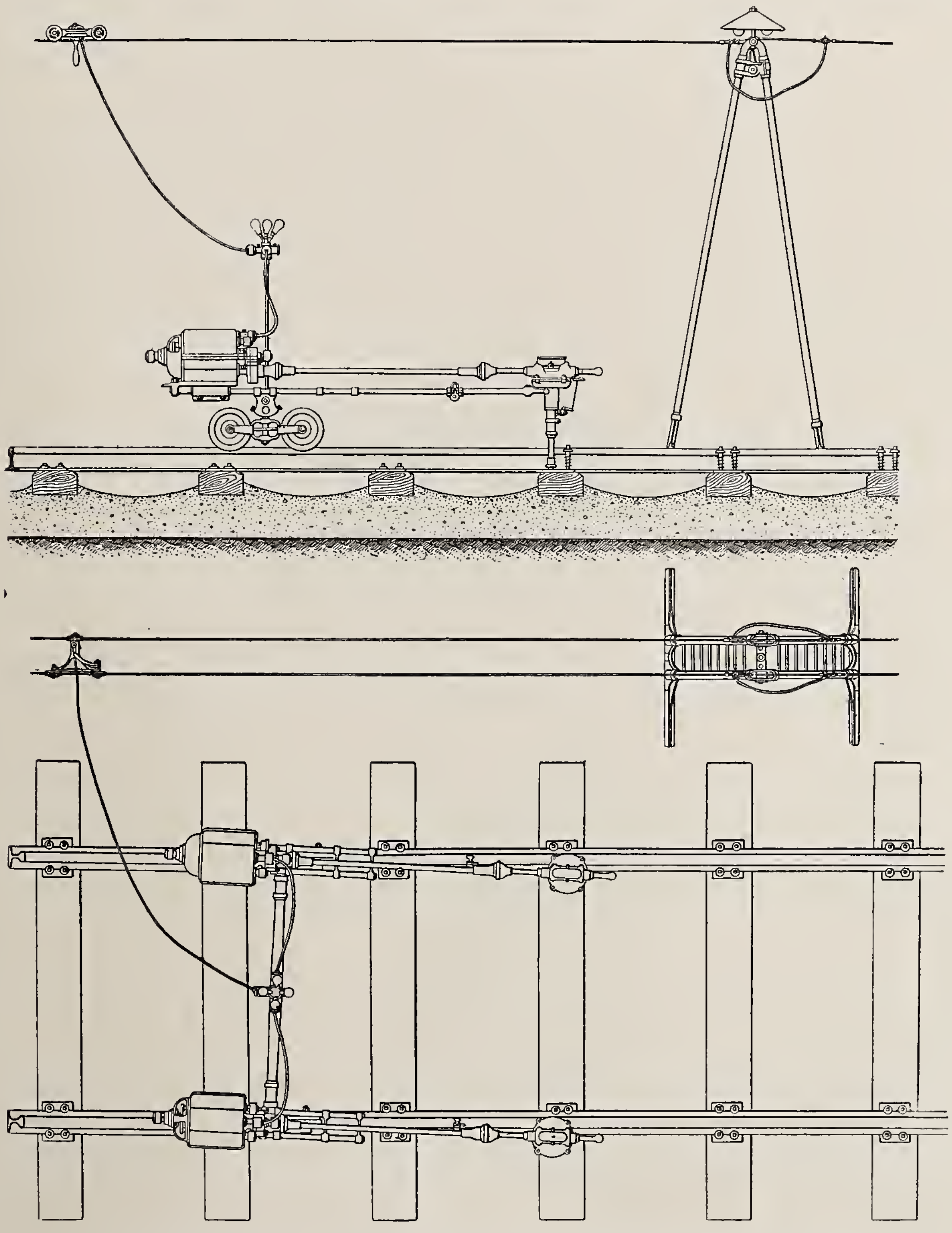


FIG. 6.—ELEVATION AND PLAN SHOWING COLLET'S SCREW SETTING MACHINE ON A LARGER SCALE, AND ALSO MORE CLEARLY EXPLAINING THE ARRANGEMENT OF THE TRANSMISSION LINE SUPPORTS

Commissioner Alexander J. Porter submitted to the commissioners a copy of an address by Charles M. Dow, chairman of the Board of Commissioners of the New York State Reservation, which emphasized the importance of preserving the falls of Niagara as a natural spectacle. He said that in 1868 the mean volume of the river was given as 273,329 cubic feet, and that for thirty-six years this had been the quoted figure, but the fact is that 224,000 cubic feet per second is the accepted figure, the equivalent discharge in horsepower being 3,800,000. He pointed out that the American and Horseshoe Falls will not be affected the same by future diversions of water, the stream being divided by Goat Island, which is 750 feet from the New York shore and 3750 feet from the Canadian shore, giving the Horseshoe Falls five-sixths of the flow and the American Falls one-sixth. But in addition to this, the rock in the American channel is 10 feet higher than in the Canadian channel, which further lessens the flow to the American Falls. It is variously estimated that only from one-fifth to one-tenth of the water passes over the American Falls. It is figured that 78,396 cubic feet of water per second are required for the present power developments, leaving only 144,006 cubic feet to continue the spectacle of the falls of Niagara.

It was feared that the complete extinction of the American Falls and the serious reduction of the Canadian Falls are imminent.

THE POSSIBILITY OF NIAGARA RIVER RUNNING DRY

Commissioner Wilkes filed with the commissioners a report of Superintendent James Wilson covering the position of the Commissioners of Victoria Park of Canada. The opinion is expressed that should the dam be erected and a minimum elevation of the level occur, all the sluice gates would be closed in response to the demands of the shipping interests, in order to secure the restoration of the levels at Buffalo harbor. This would allow the river to run practically dry for the time being, a thing that should not be permitted under any circumstances, particularly when the whole object of the scheme appears to be to save dredging the harbors on Lake Erie and to facilitate the

making of a 21-foot channel from the United States side of the Niagara River to Lake Huron, the cost of which, if the water was raised in Lake Erie, would be about $1,375,000 less than would be required should the present conditions be allowed to remain. The report also stated that because of the construction of the Chicago Drainage Canel the water surface of Lake Erie has been permanently lowered about 4½ inches and the volume of the Niagara River and all the waters from Lake Huron via the St. Lawrence to the sea has been likewise depleted.

Representing the Niagara Falls Power Company, Attorney Lovelace presented data and expressed the belief that any artificial interference with the natural levels would be detrimental to Niagara, where, outside of the big investments of the power companies, there was about $8,000,000 invested in new industries. Hon. Arthur Schoellkopf, an officer of the Niagara Falls Hydraulic Power & Manufacturing Company, said that if any further obstructions were placed in the Niagara River his company would be unable to meet the demands of customers for power, which would mean great financial loss. The Ontario Power Company, Canadian side, promised to file a brief in the near future.

Building Trades Lectures

THE West Side Young Men's Christian Association, New York City, is offering this year some practical lecture courses for men in building trades. A set of illustrated lectures on construction will be given, to enable men to thoroughly understand every part of a building. These talks will not be highly technical, but sufficient for general work, and most illustrations will be from actual building.

The entire course is under the direction of L. E. Jallade, architect; with the following assistants:—

Charles E. Hume, general building; Joseph W. Cody, excavating and shoring, ex-emergency chief of the New York Building Department; Charles E. Stanton, sheet metal work; Louis Kreis, cut stone; Edward Raque, C. E., steel, with Post & McCord, New York; Jacob M. Kraft, plaster; Alfred W. Norris, carpentry; J. F. Burrowes, ornamental iron, with J. B. & J. M. Cornell, New York; Charles R. TenEyck, terra-cotta, with New York Architectural Terra-Cotta Company; John Dalglish, hardware, with Yale & Towne Company; Henry H. Ritter, M. E., heating; J. R. Shields, electric.

The classes opened on October 2, at night, and will continue for four months at the Y. M. C. A., 318 West Fifty-seventh street.

The Colorado Electric Light, Power and Railway Association

THE third annual meeting of the Colorado Electric Light, Power and Railway Association was held at Glenwood Springs, Col., on September 18, 19 and 20. The membership of the association comprises about 50 per cent. of the central station companies doing business in the State of Colorado. The following papers were presented:—

"Notes of an Up-to-Date Sub-Station," by A. M. Ballou.

"A New High Candle-Power Incandescent Lamp," by C. B. Mahaffey.

"The Application of Electric Power to Gold Dredging," by J. F. Dostal.

"Isolated Plants," by H. L. Wolfenden.

"Getting New Business," by R. L. Goodale.

"The Mercury Arc Rectifier," by G. N. Robinson.

The officers of the association are:—President, F. W. Frueauff, general manager of the Denver Gas & Electric Company, Denver, Col.; vice-president, Wm. Mayher, manager of the Greeley Power & Light Company, Greeley, Col.; secretary and treasurer, George B. Tripp, general manager of the Colorado Springs Electric Company, Colorado Springs, Col.

Additional members of the executive committee are:—J. A. Beeler, president of the Denver City Tramway Company, Denver, Col.; J. F. Vail, general manager of the Pueblo & Suburban Traction Company.

The development of the gas engine has proceeded at a much more rapid rate on the other side of the Atlantic than with us. Figures of the consumption of gas from city plants give a good idea of this. In many German cities from 15 to 25 per cent. of the total gas generated is consumed by the engines, while some 5 per cent. of the total output of the Paris plants is utilized in the same way. In American cities scarcely an example can be found where as much as 1 per cent. of the total gas manufactured is supplied for operating gas engines. It is expected, however, that in cities where the price is below $1 per 1000 cubic feet, the use of it for power purposes will increase.

Electrification Projects at Duluth

BOTH the General Electric and the Westinghouse Electric companies are now engaged in formulating plans for the electrification of Proctor Hill, on the Duluth, Missabe & Northern Railroad. This is a 2 per cent. grade for about 6 miles, running from the shipping docks of the company on the harbor of Duluth to the terminal and transfer yard of the company at Proctor, Minn. Loaded ore trains from the mines are run to Proctor and there taken by switch engines down to the docks. The same engines bring back empty cars, which are made up for the return trip to mines at Proctor yard. About 2500 H. P. will be required for handling trains on this grade, and if arrangements are made with either company for an installation, the power will be furnished by the Great Northern Power Company, which is now building its hydro-electric works at Duluth.

The same companies are now working out plans for the possible electrification of the Duluth-St. Paul line of the Northern Pacific Railroad. This line connects Duluth and Superior with Minneapolis and St. Paul, and is about 165 miles in length, with a very heavy freight and passenger traffic. With the exception of a 1 per cent. grade out of Duluth, and slightly steeper entrance into St. Paul, the line is reasonably free from gradients. It is one of three steam lines connecting these cities, and carries an immense amount of coal and package freight as well as some grain, and runs several passenger trains each way daily.

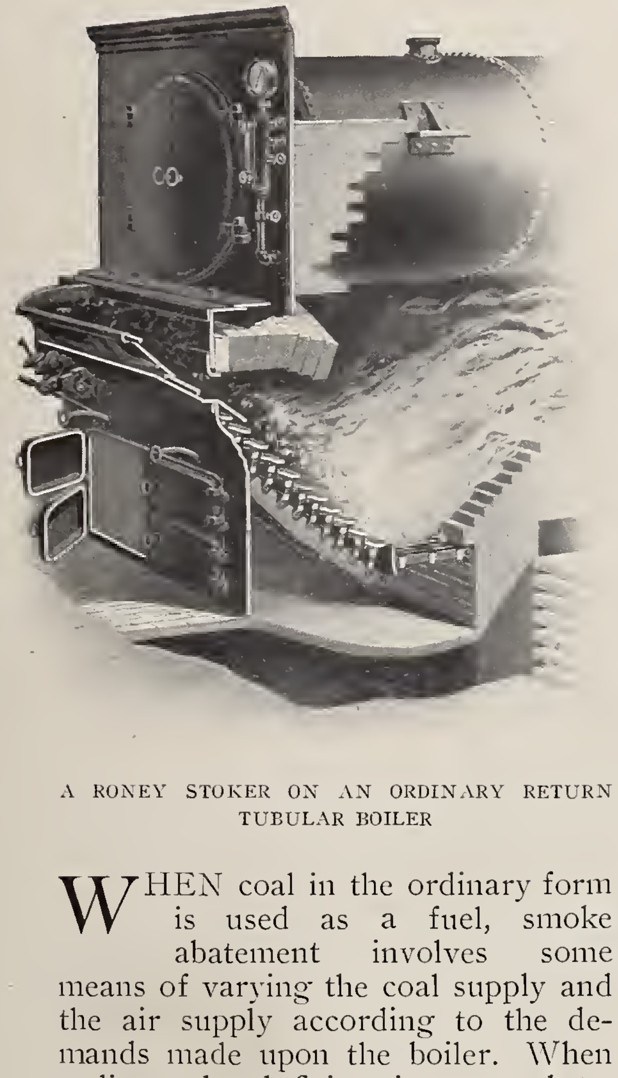
The second project is not so sure as the first and may not come for a considerable time. The successful electrification of the Duluth, Missabe & Northern's terminal line will mean that electrical railroading will be extended to the entire length of that line as well as to both the other roads reaching from the iron ore ranges to Duluth. Then, too, both companies, looking toward the electrification of mines and mining plants on the iron ranges of Minnesota, have had engineers in the district. These have been acquainting themselves with power plants and requirements and noting the conditions under which work will have to be done, as well as with the class of power needed and its continuity.

According to Professor Toit, if the water in the ocean was not compressed as it is by its own weight, the level of the sea would be 116 feet higher than at present.

Mechanical Stokers as Smoke Preventers for Power Houses

By CHARLES H. BENJAMIN

At a meeting of the American Society of Mechanical Engineers, held last June, Professor Charles H. Benjamin read an interesting paper entitled "Smoke and Its Abatement." From this, the following extracts have been made, referring specially to the use of mechanical stokers as smoke preventers, and being correspondingly interesting to power-house superintendents. Professor Benjamin has served as city smoke official of Cleveland, Ohio, and as such has given the smoke problem close study and attention.—The Editor.



A RONEY STOKER ON AN ORDINARY RETURN TUBULAR BOILER

When coal in the ordinary form is used as a fuel, smoke abatement involves some means of varying the coal supply and the air supply according to the demands made upon the boiler. When ordinary hand firing is resorted to, the great irregularity of the coal supply will cause poor combustion and smoke unless the air supply is varied to correspond. Steam jets are frequently employed under these circumstances, and, if properly put in, will improve the combustion by drawing in additional air over the grate and mixing it with the products of combustion in front of the bridge wall. The steam jet should be semi-automatic, the steam and air being turned on by the opening of the fire door and gradually closed off by a dash-pot attachment.

The best solution of the smoke problem, so far, has come from the introduction of mechanical means of handling the coal, which give a uniform feed to the fuel and a corresponding delivery of air for combustion. The use of mechanical stokers has been brought about by the natural demand for machine handling in large power plants as more economical than human labour, rather than by a philanthropic desire to benefit the community.

It has been estimated that one able-bodied man with a shovel and slice-bar can take care of 200-H. P. of boilers. With good mechanical stokers he can handle double, and with complete coal and ash-handling equipment three times this amount. Stokers may be divided into three principal classes:—Inclined, shaking grates; traveling or chain grates; and underfeed stokers.

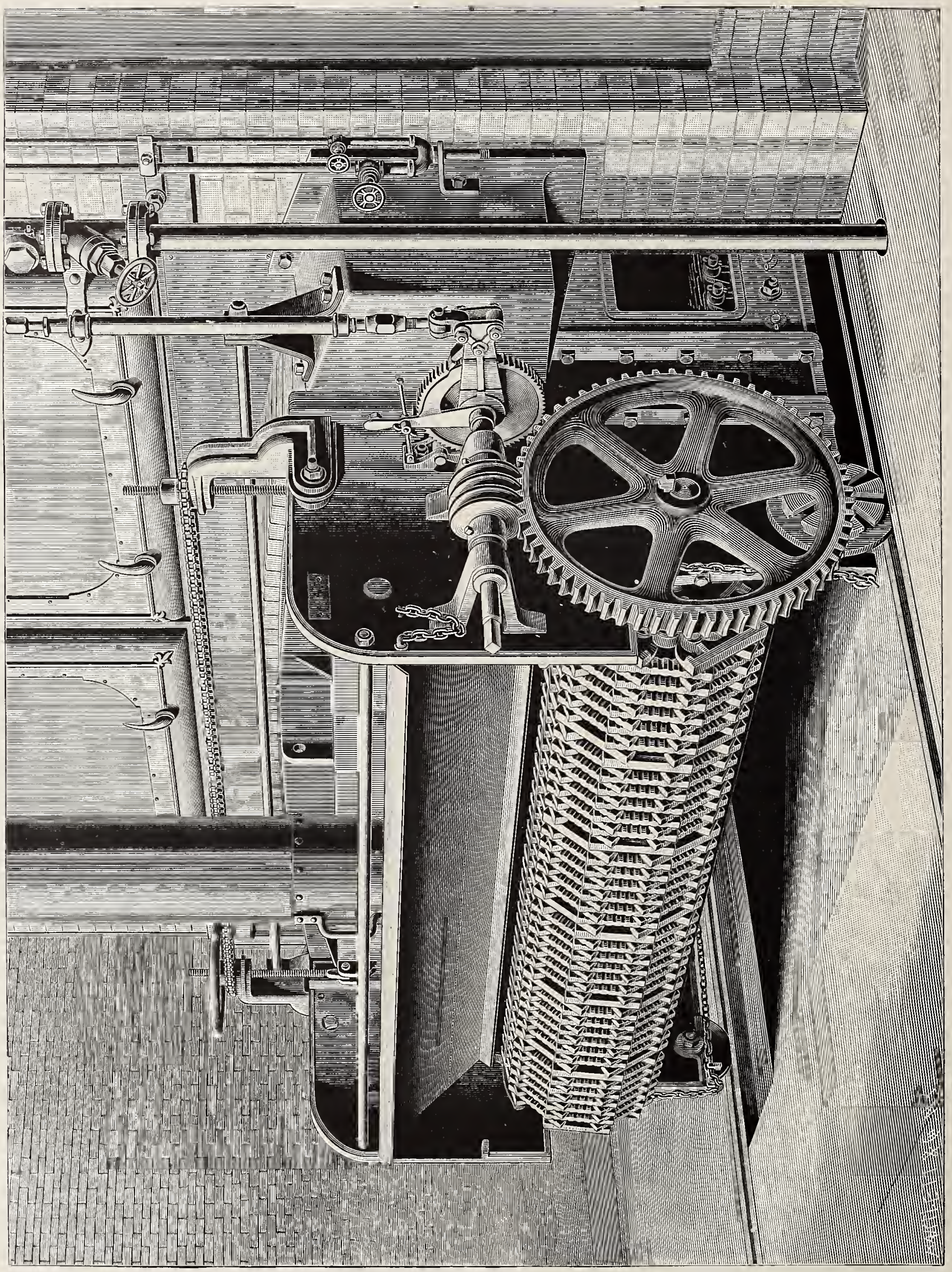
The inclined grate, as exemplified in the Wilkinson, Brightman and Roney stokers, has a hopper in front and slopes down and back, having a clinker grate just in front of the bridge wall, while the double incline, as in the Murphy and Detroit stokers, has a magazine on either side and slopes in two planes parallel to the axis of the boiler, meeting in a clinker grate at the bottom. The principle of action is practically the same and involves the slow coking of the coal on a dead-plate, the pushing forward on to the top of the incline and the gradual descent, impelled by oscillation of the grate bars, until the combustion has left nothing but ash and clinker at the bottom. Air is usually admitted both below and above the grate, and the hydrocarbons which are distilled at the top of the grates pass through the intense heat of the burning coke on their way to the bridge wall and are completely burned. The double incline usually has a revolving clinker bar which disposes of some of the ash automatically, but as a rule both forms need considerable cleaning.

When used with a fuel which does not cake or clinker too much and when not crowded too hard these stokers are economical and reduce the smoke considerably. If, however, it becomes necessary to slice and poke the fire on account of caking coal or overcrowded boilers, unburned masses of coal are rolled to the bottom and holes are made in the fire through which cold air rushes. Both of these circumstances make for poor combustion and a smoky fire. As a rule firemen poke the fire on stokers too much, doing more harm than good.

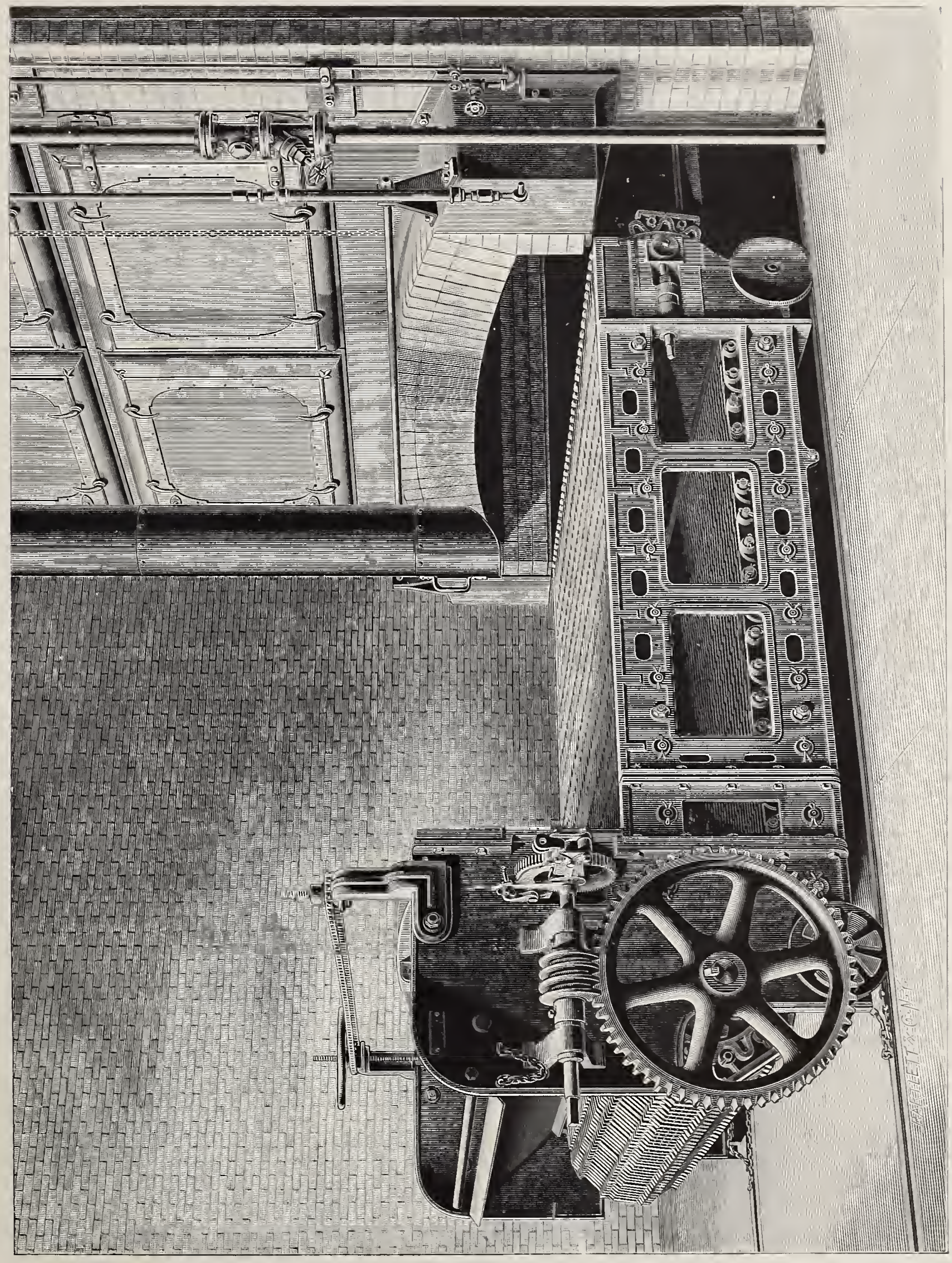
I have seen inclined grate stokers carrying a heavy fire and developing much more than the rated capacity of the boiler with very little slicing and hardly a trace of smoke. Cleaning is usually a source of black smoke for a few minutes, but this is mostly unnecessary if the fireman understands his business and gets his fire ready for cleaning beforehand. I think the middle door in the Murphy furnace is sometimes a disadvantage, as it tempts the fireman to meddle with the fire when he had much better leave it alone.

The traveling or chain grate is rapidly coming into favour as a means of stoking automatically. It consists, as in the Babcock & Wilcox and Green stokers, of an endless horizontal chain running on sprocket wheels and carrying the coal back under the boiler, finally dumping the refuse over the back and into the ash-pit. The distilling process and the gradual burning of the coke are much the same as in the stokers just described. In order to prevent waste through the grates the latter are usually quite close, and it becomes necessary to use more draft than with ordinary grates.

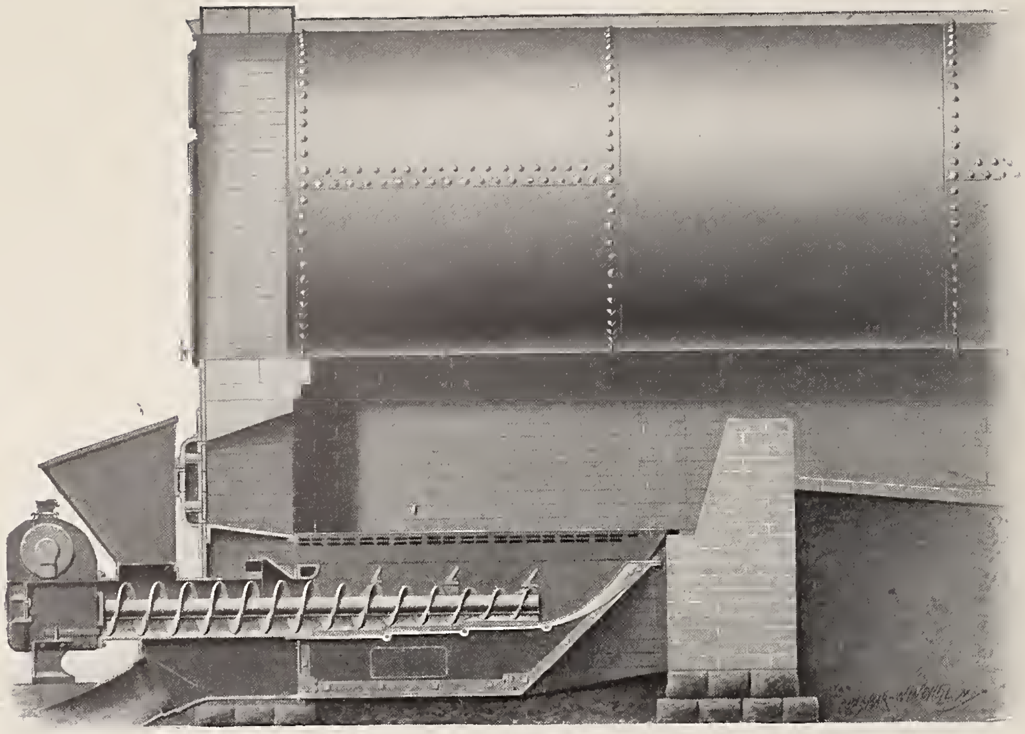
A damper is used underneath the grate to prevent an excess of air from passing up behind the grate. Some tests recently made by a large corporation which uses a considerable number of the chain grates showed an evaporation of only 5.7 pounds of water per pound of coal. An examination disclosed the fact that a large excess of air was passing through the comparatively bare grate at the rear



CHAIN GRATE STOKER MADE BY THE BABCOCK & WILCOX COMPANY, NEW YORK. THE STOKER IN FIRING POSITION. THE COAL IS FED THROUGH A HOPPER OF THE FULL WIDTH OF THE GRATE, AND THE DEPTH OF THE LAYER IS REGULATED BY A DOOR WHICH CAN BE LIFTED OR LOWERED



THE BABCOCK & WILCOX STOKER DRAWN OUT FOR INSPECTION OR REPAIRS. THE APPARATUS AS A WHOLE IS MOUNTED ON WHEELS RUNNING ON RAILS PLACED ON THE SIDES OF THE ASH PIT, AND CAN BE DRAWN OUT CLEAR OF THE BOILER FOR INSPECTION OR REPAIRS OR TO GIVE ROOM WHEN NECESSARY TO REPLACE FURNACE LININGS



TYPICAL SETTING OF AN "AMERICAN" UNDERFEED STOKER UNDER A RETURN TUBULAR BOILER. MADE BY THE AMERICAN STOKER COMPANY, ERIE, PA. EACH STOKER IS USUALLY DRIVEN INDEPENDENTLY BY A SMALL RECIPROCATING STEAM MOTOR, LOCATED IN FRONT OF THE HOPPER. THE RATE OF FEEDING THE COAL IS CONTROLLED BY THE SPEED OF THE MOTOR, WHICH IS REGULATED BY SIMPLY THROTTLING THE STEAM IN THE SUPPLY PIPE TO THE MOTOR

end. The introduction of a damper to regulate this brought about a great improvement.

With the same fuel and same conditions as before, an evaporation of eight pounds of water per pound of coal was obtained. Intending users of chain grates would do well to bear this in mind. From observations covering a period of several years I have come to the conclusion that this type of grate is the best one yet devised for abating smoke.

The fact that it is horizontal, so that unburned coal cannot run to the rear end, and the further fact that it is self-cleaning and need not be disturbed by the slice-bar, make it an almost ideal furnace in this respect. If run by an intelligent fireman who understands adapting the depth and travel of the fire to the work to be done, it will also be a very economical furnace.

The underfeed stokers operate on an entirely different principle, the coal being fed in underneath the grate and forced up through a rectangular opening in the center. A forced blast is used and the air for combustion is blown up through the coal, the tuyeres being on either side of the rectangular opening just mentioned. By this arrangement the fresh coal is always underneath and the distilled gases are obliged to pass through an incandescent mass of fuel in company with the air. With a proper pressure of blast perfect combustion is thus almost unavoidable. The ash and clinker are now at the top of the fuel, which forms a gradually rising mound in the center and pushes the clinker over to either side, whence it is removed by hooks through doors at the front. The heat generated is such that the ash generally melts and forms a sheet of clinker which can be easily removed without disturbing the fire.

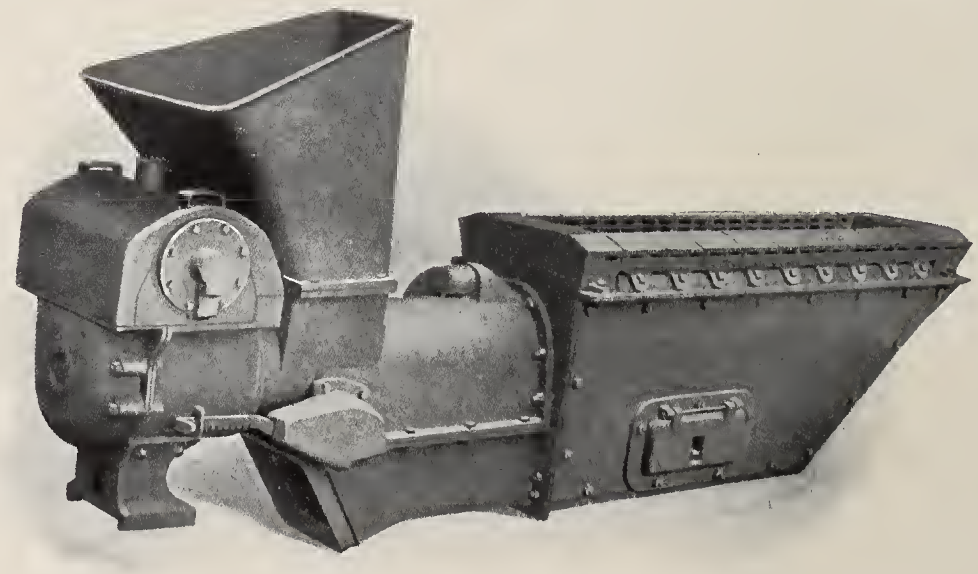
In the American stoker the coal is forced under the grate and up by a revolving screw, somewhat similar in shape to the ordinary gimlet pointed lag screw. In the Jones underfeed stoker a plunger driven by steam operates to feed the coal. This plunger can be arranged to start and stop by hand or to run automatically. My experience has shown the underfeed stoker to be economical in operation and practically smokeless.

A criticism frequently made in regard to mechanical stokers is that they will not respond quickly to sudden changes in the load, that it is difficult to keep a uniform steam pressure under such circumstances, and that for this reason they are not economical. There is some truth in this. It is easy to conceive of circumstances, especially in electric plants, under which it would be difficult to maintain a uniform steam pressure with either the oscillating or the traveling grate. For regular fluctuation of load, as in electric lighting or railway power houses, the obvious remedy is the introduction of storage batteries and the provision for ample boiler reserve.

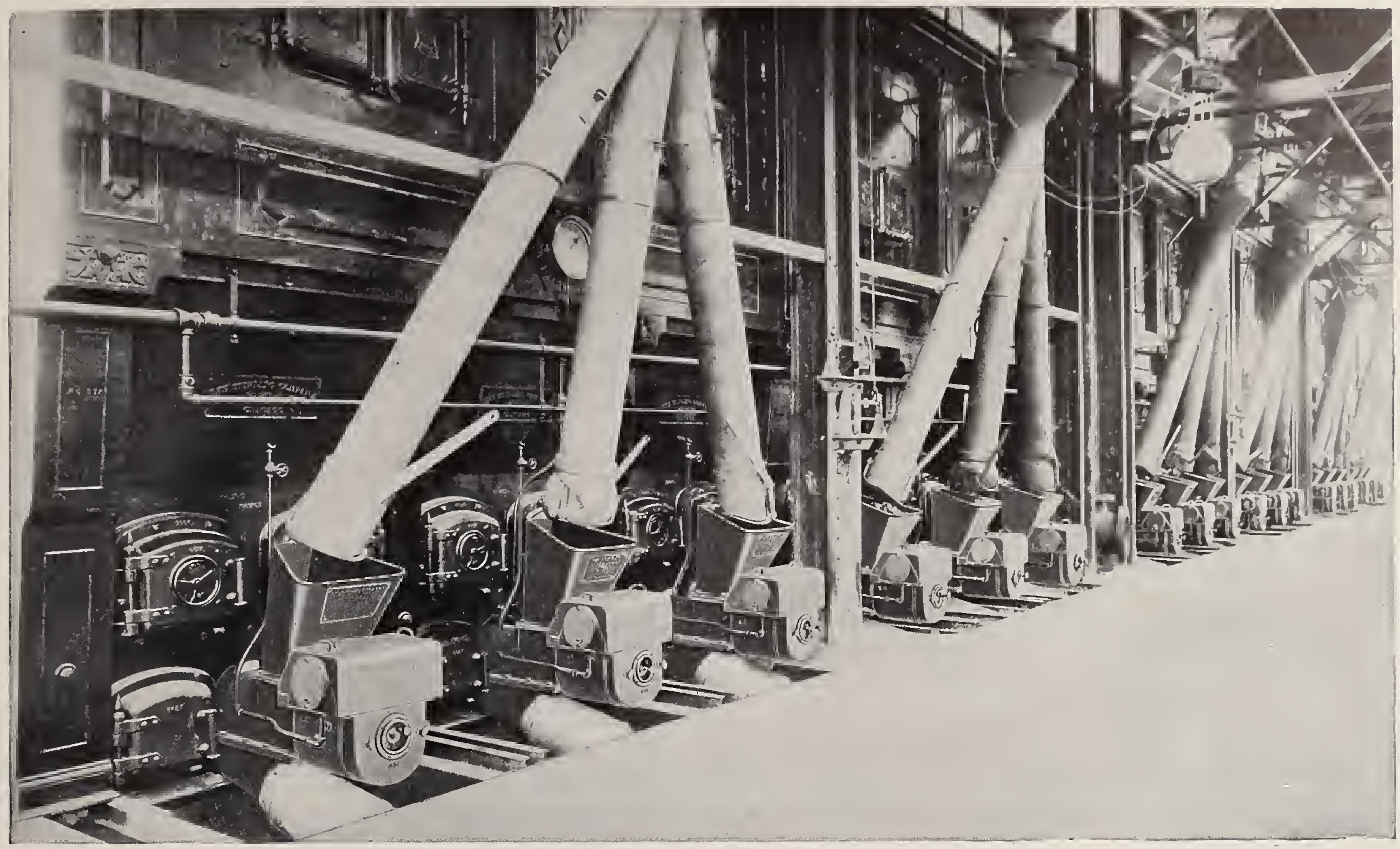
Minor fluctuations can be taken care of by the fireman unless they become too numerous or too violent. In the latter case the underfeed stoker with the plunger feed comes the nearest to satisfying the demand. With the power of instantly regulating the motion of the plunger and the pressure of the blast, it is thus possible to meet emergencies of this kind more promptly than by hand firing.

With the complaint sometimes made that stokers cannot be forced, I have no sympathy. With an ordinary inclined grate stoker under a horizontal tubular boiler, I have forced a boiler to 75 per cent. above its rating with practically no smoke and with an evaporation of over eight pounds of water per pound of bituminous slack. It all depends upon the draft and upon the intelligence of the fireman. Probably, however, none of us believe in forcing a boiler to this extent; it is bad for the boiler, bad for the stoker and bad for the coal pile.

The economy resulting from the abatement of smoke is naturally a potent argument in its favour. This phase of the subject has, however, but little to do with the ethics of the



A STANDARD 10-INCH "AMERICAN" STOKER. THE APPARATUS IS ENTIRELY SELF-CONTAINED



SIX 500-H. P. BOILERS, MADE BY THE STIRLING COMPANY, NEW YORK, EQUIPPED WITH "AMERICAN" UNDERFEED STOKERS

question. Once prove that it is practicable to abate smoke and the community has a right to insist on its abatement regardless of economical considerations. It may cost me more to haul away my garbage than to throw it into my neighbour's yard, but that is no argument for my imposing upon my neighbour.

Fortunately this difficulty does not exist in most cases, for it may be stated as a general proposition that smoke abatement means economy in fuel consumption. The proof of this statement is extremely simple: fuel economy results from good combustion, good combustion is accompanied by little visible smoke. It must be remembered that the converse is not necessarily true, for a smokeless chimney does not always mean good economy. An excess of air may insure entire oxidation of the combustible matter and at the same time so dilute the chimney gases as to cause serious waste of heat.

The problem to be studied by the manufacturer should be how to obtain the most perfect combustion of the particular fuel which he uses and then the smoke question will take care of itself. Let him make frequent analyses of chimney gases, compare different pressures of draft and different dispositions of dampers and he will be repaid for his trouble in more ways than one.

Personally I believe in the automatic stoker as the most economical solution of the problem. In forming this opinion I do not rely upon expert tests for efficiency; there are so many variables entering into the question that it is difficult to make accurate comparisons in this way. As it is entirely possible to improve the efficiency of a furnace 10 or 15 per cent., by intelligent hand firing, there is much difficulty in determining the actual saving effected by a stoker. During a competitive test between the hand-fired furnace and the stoker the conditions are often entirely different from those obtained in every-day use, and these changed conditions are usually more to the advantage of the hand firing. By this I mean that good hand firing is the exception rather than the rule, on account of the dirty, disagreeable nature of the work and the low grade of help employed.

With the introduction of mechanical handling there is a reduction in the quantity of manual labour and there should be an improvement in its quality. Manufacturers should understand that if they expect to get the benefit of improved machinery they must have men competent to run it to the best advantage.

The surest method of determining the relative economy of the two methods is by comparing the coal bills before and after the change, making due allowance for any variation in the work done. This has been done in a number of instances to my knowledge, and the result has always been favourable to the stoker. About a year ago I addressed letters to a number of business men and manufacturers who have installed mechanical stokers of various sorts in factories and office buildings, asking for information as to the value as smoke-abating devices of the particular stokers used, and as to the fuel economy and the cost of repairs.

The replies in every case were favourable to the stoker, both as regards smoke abatement and as regards general efficiency. There are in the city of Cleveland fifteen large office buildings, ranging from eight to sixteen stories in height, which have mechanical stokers in connection with their power and heating plants. It is doubtful if any such building will be erected in Cleveland in the future without an equipment of this sort.

One manager of a ten-story office building writes that he has three 200-H. P. stokers which have been in use for four years, burning slack coal, and that the only repairs have been the replacing of brick linings at a total expense for the four years of only $50 per furnace. The following quotation from a letter written by the manager of a large storage warehouse explains itself:—

"We installed under our four boilers

stokers known as the ———, and they all went into service on March 1, 1903. Our chief object in installing the stokers was to abate the smoke, and this they accomplish to such an extent that our chimneys are practically smokeless, and in addition to this we saved 500 tons of coal for the year. This we think is a fair showing, and thus far we have been put to very little expense in keeping them in repair."

An extract from another letter is as follows:—"The stokers cost approximately $1500. The annual saving of fuel is $550. The demand for steam is increased 10 to 15 per cent."

Personal letters from well-known business men in Cleveland testify to a saving in fuel varying from 15 to 25 per cent. A very conservative letter from the chief engineer of one of the largest power houses in the city contains some criticisms of faults in the various stokers used, but concludes as follows:—

"While it is impossible for me to ignore the weakness in the above stokers, yet I would certainly recommend the use of either of these stokers over hand-firing in a plant of any size using bituminous coal."

The business policy of some of the largest corporations forbids letters of commendation for any mechanical device whatsoever, but I am in position to know that exhaustive tests covering a period of months have shown the economy of the new way in a most satisfactory manner. This is further evidenced by the fact that these "soulless corporations" are changing to the mechanical stoking as rapidly as the pressure of business will allow.

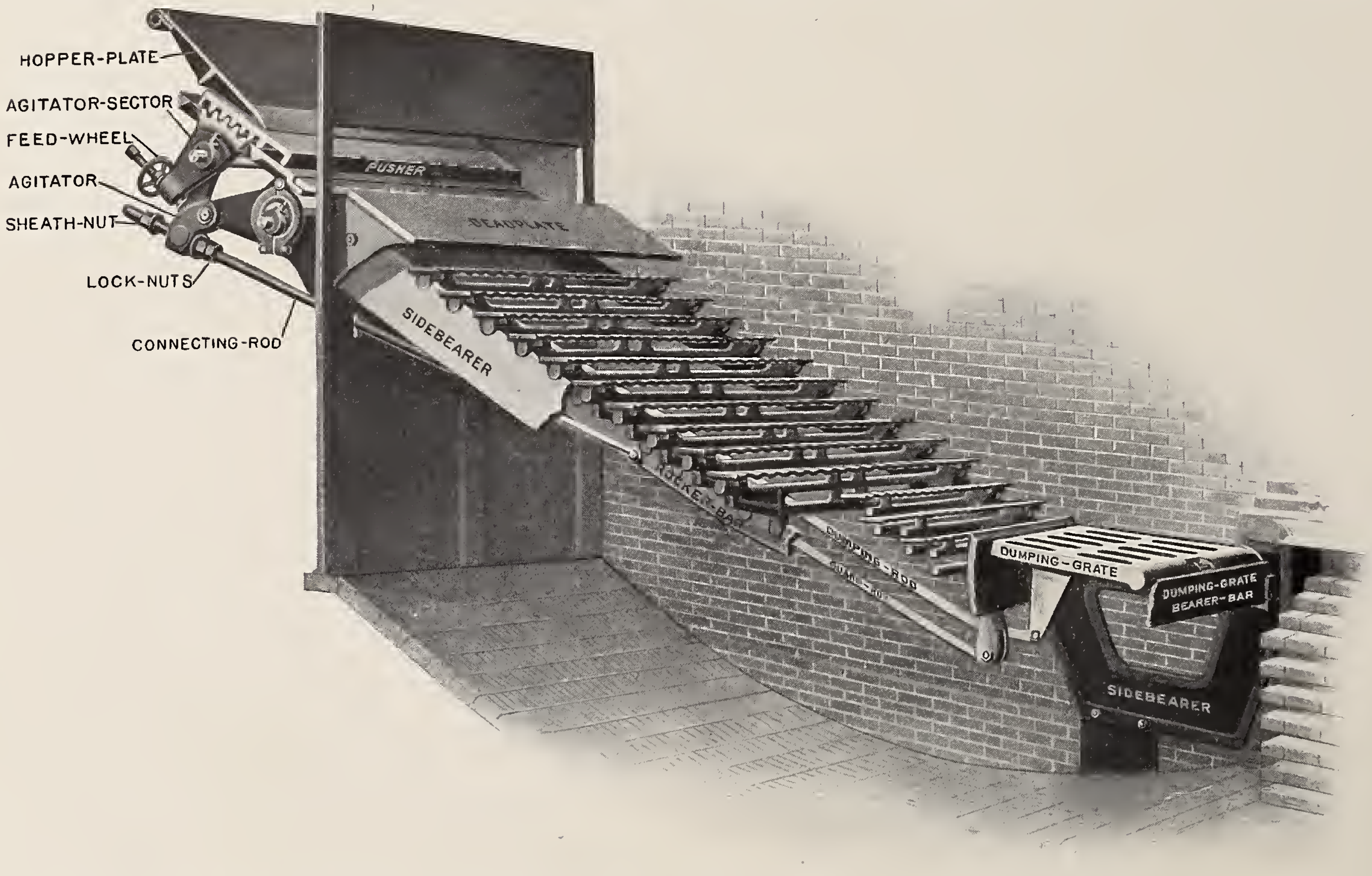
One suburb of Cleveland containing large steel works has been redeemed in the most remarkable manner by the introduction of automatic stokers, so that there is now a place for human beings to live, where formerly all was soot and blackness. The president of a manufacturing company using four stokers reports that he is not only paying from fifty to seventy-five cents less per ton for his fuel, but is burning six tons less per day than formerly, and at the same time getting better satisfaction in the maintaining of a uniform steam pressure.

It is undoubtedly true that the agents of smoke-abating devices of all sorts have been extravagant in their claims and that they have damaged their own business by such claims, but this is a mistake not confined to the furnace business.

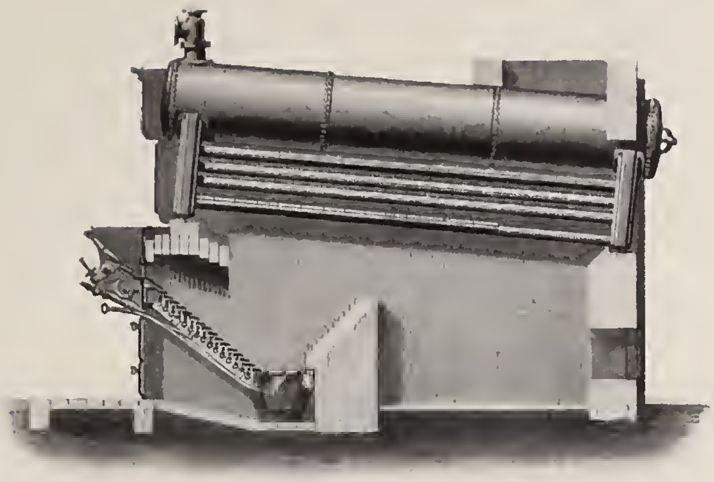
A conservative claim of from 10 to 20 per cent. saving, depending upon how smoky the furnace has been, can usually be substantiated by a comparison of the coal bills before and after introducing stokers, without resorting to expert tests. I have known so simple a thing as an automatic steam and air jet to pay from 50 to 100 per cent. annually on the original investment, as determined by the coal bills.

If I have said little in this paper about means for smoke abatement other than stokers, it is because I believe that the stoker is the best remedy where it can be used, and that it should always be adopted in new power plants.

Whenever for any sufficient reason the stoker cannot be introduced, there are other devices which will mitigate the smoke nuisance considerably and also save fuel. The steam and air blast has already been mentioned. A recent improvement which promises well is the combination of steam jets at the bridge wall with oil vapour,



SECTIONAL PERSPECTIVE OF THE RONEY MECHANICAL STOKER, MADE BY THE WESTINGHOUSE MACHINE COMPANY, PITTSBURG. THE COAL IS FED ONTO THE INCLINED GRATE FROM THE HOPPER BY A RECIPROCATING PUSHER, ACTUATED BY AN AGITATOR AND AGITATOR-SECTOR, WHICH RECEIVE THEIR MOTION THROUGH AN ECCENTRIC FROM A SHAFT ATTACHED TO THE STOKER FRONT UNDER THE HOPPER. THE GRATE-BARS ROCK THROUGH AN ARC OF 30 DEGREES, ASSUMING ALTERNATELY THE STEPPED AND THE INCLINED POSITION



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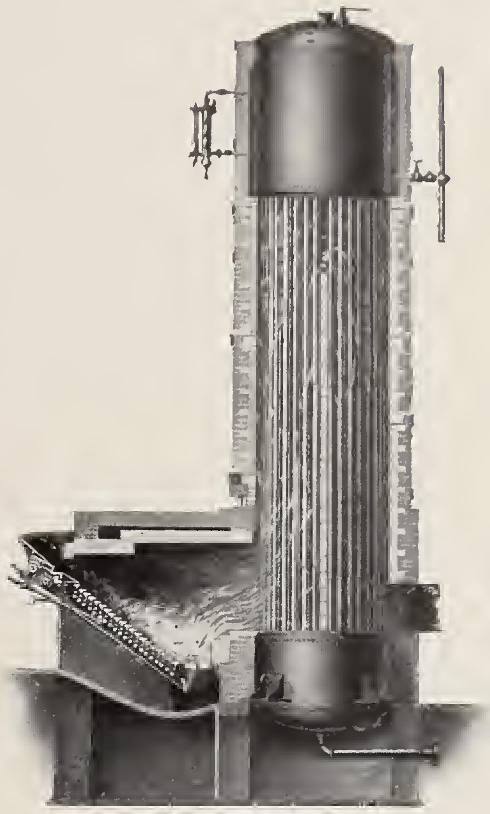
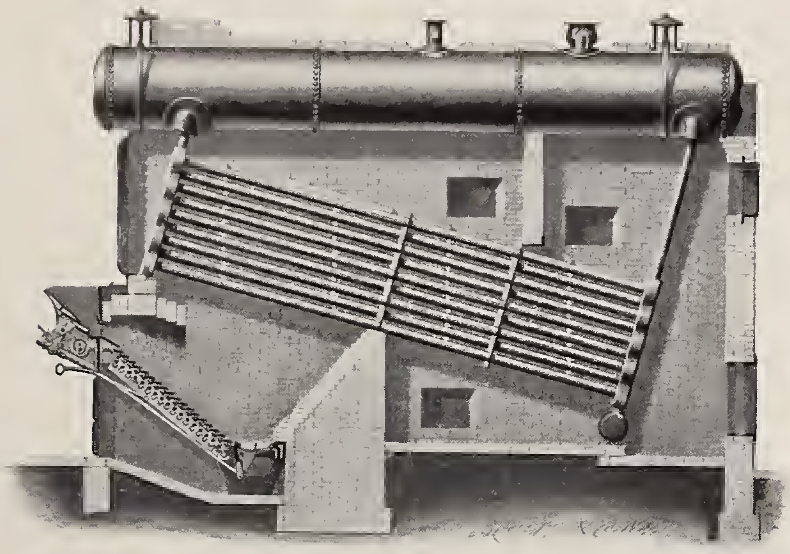
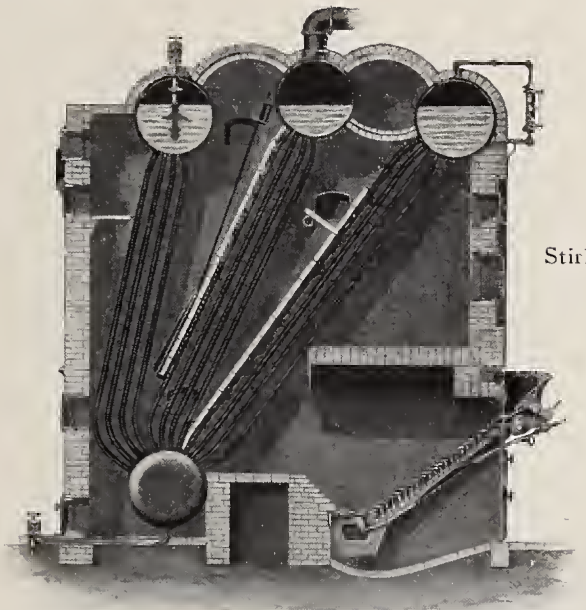


Wickes



Babcock & Wilcox



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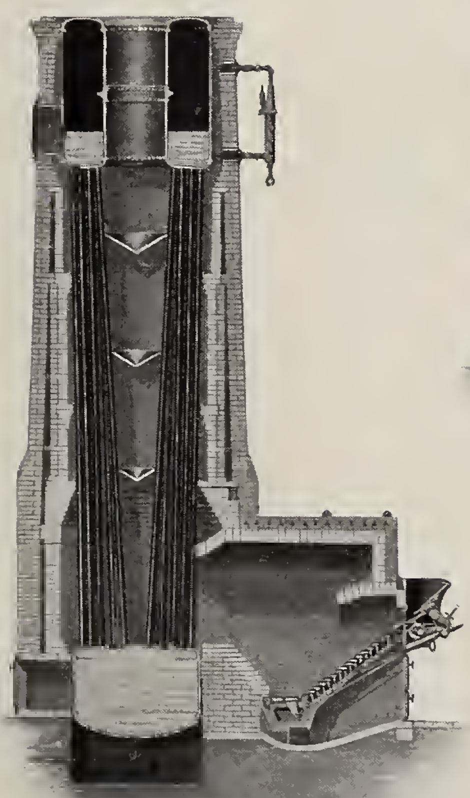

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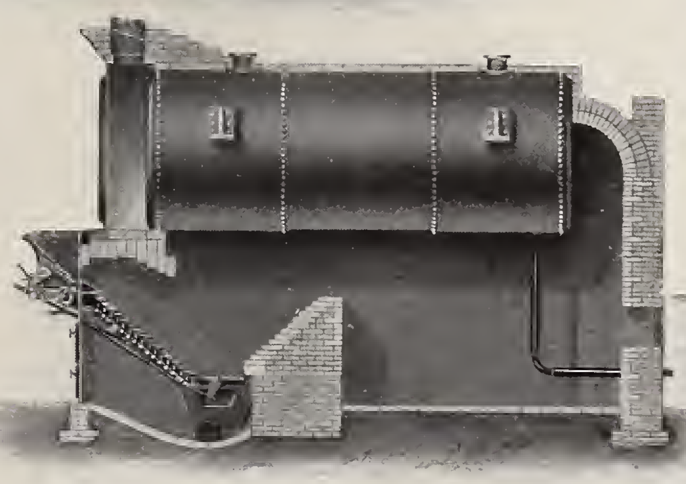
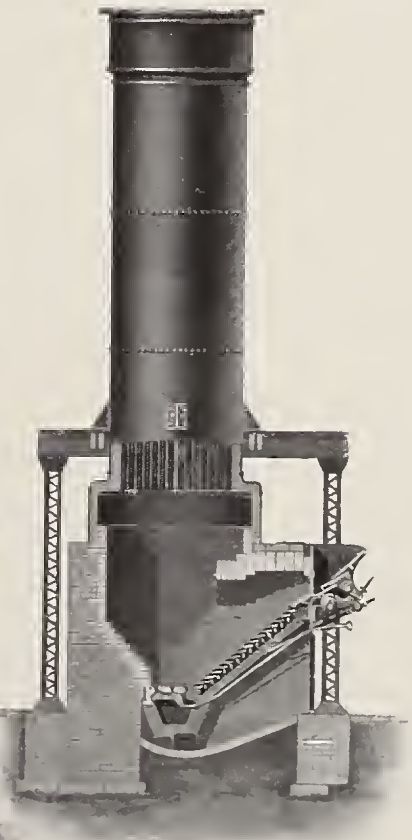
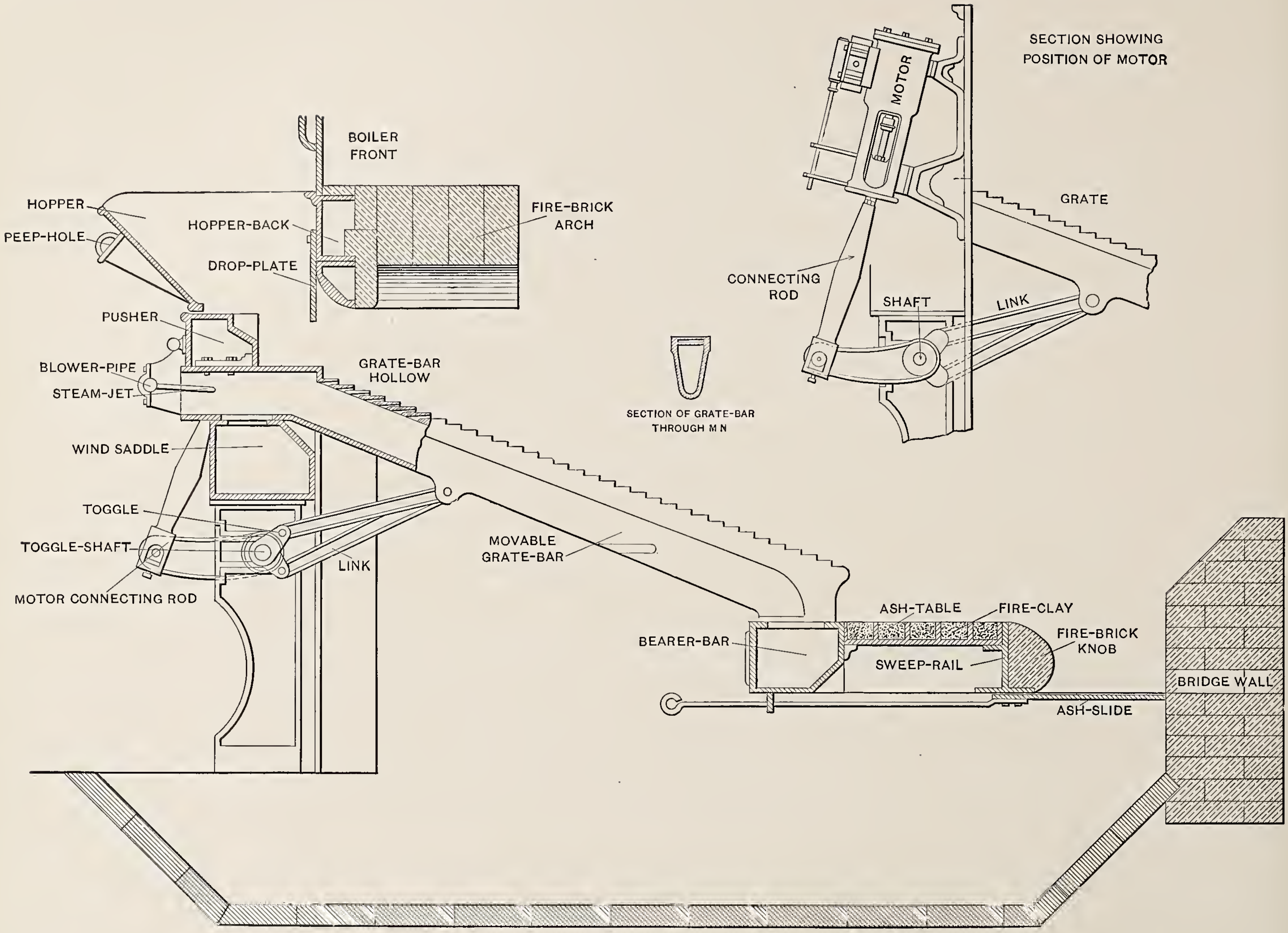


Return Tubular



Manning

THE RONEY MECHANICAL STOKER APPLIED TO DIFFERENT MAKES OF VERTICAL AND HORIZONTAL BOILERS



THE MECHANISM OF THE WILKINSON STOKER. MADE BY THE WILKINSON MANUFACTURING COMPANY, BRIDGEPORT, PA. THERE IS A CONSTANT SAWING ACTION OF THE GRATE BARS, CAUSING THE FUEL TO FLOW FORWARD AND DOWNWARD, ACCOMPANIED BY A CONSTANT INFLUX OF STEAM AND AIR

creating an intense heat at that point and consuming the hydrocarbons as they pass through. The expenditure of oil is comparatively small and considerable economy is said to result.

Brick arches and baffle walls have also assisted in maintaining a high temperature and in properly mixing the gases. The use of a reverberatory furnace or outside oven in which the coal and its gases are thoroughly burned before going to the boiler is another satisfactory method of reducing smoke, and may be used as well with as without a stoker.

In closing I wish to call attention briefly to the legal aspect of the question, although this may not interest engineers as much as does the scientific aspect. I believe that the municipalities have a right to insist upon the abatement of black smoke by all users of steam boilers, without regard to the purposes for which the steam is used or the means to be adopted for abatement. This, because smoke is a public nuisance and because it can be abated without hardship to the owner of the plant. Nevertheless, when the evil is present and has been present for a period of years, it is not good policy to be too radical in the enforcement of the statutes. The law should be definite and stringent and the penalties adequate, but they should be enforced with discretion by officials who have some technical and practical knowledge of smoke abatement.

It is absurd to talk of putting this matter into the hands of the police or of the health officer. The official having charge of this work should be a trained engineer, if possible a technically educated man, and he should be entirely above graft in any of its disguises.

Some years ago I was indicating to the municipal committee of a commercial club in a Western city qualifications for a smoke inspector somewhat similar to those just mentioned, when the secretary of the club, turning to his associates, remarked solemnly; "Gentlemen, I do not see but what we will be obliged to get an angel for this position."

As a rule, very little attention should be paid to complaints, since they are usually inspired by prejudice and neighbourhood jealousy rather than by any knowledge of the actual conditions. The inspector should be in a position to know the condition and characteristics of each chimney, and these should be determined by systematic observations made by a trained assistant. The observations should be made each five minutes and should cover all the time during which the chimney is visible.

To summarize the facts and principles of smoke abatement, I would repeat:—

(1) Black smoke is a public nuisance and should be regulated by legal means.

(2) It is a result of imperfect com-

bustion and can be largely abated by proper methods of stoking.

(3) Mechanical stokers offer the best means of accomplishing this result, in medium-sized or large plants.

(4) As smoke abatement is a result of better combustion, economy of fuel is the natural and obvious result.

To these I would like to add one more, a principle which is common to all reforms:—

(5) An educated and intelligent public sentiment must be the moving and compelling force, without which mechanical devices and legal enactments will both fail.

When the public comes to realize its rights in this matter and that it is under no more obligation to submit to this nuisance than it is to endure bad drainage or filthy streets, laws will be enacted and enforced and the people will wonder that they so long submitted to this unreasonable imposition.

An attractive field for the development of wireless telegraphy has been opened by the organization of the Panama Canal project, and the Bureau of Equipment of the Navy Department has under consideration the feasibility of establishing wireless connection between New Orleans and the isthmus.

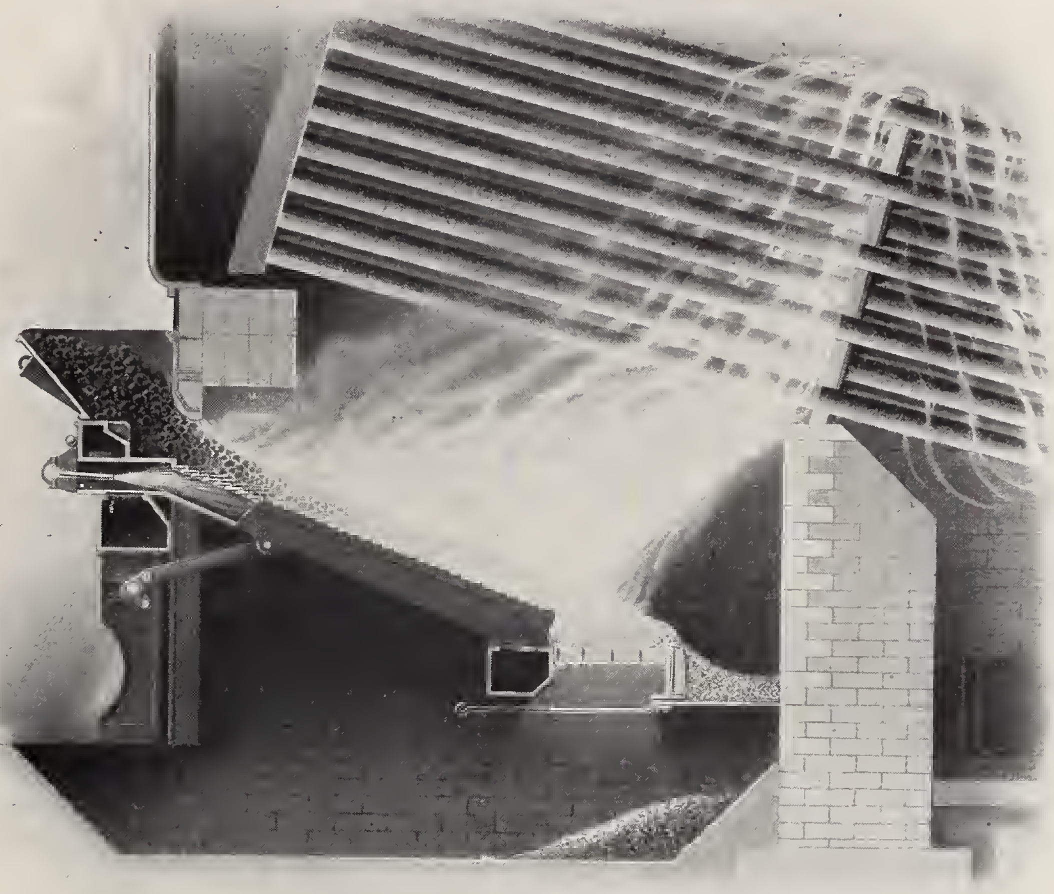
The True Function of the Engineer

SPEAKING recently at Purdue University, Henry R. Towne made the point that the dollar is the final term in almost every equation which arises in the practice of engineering in any or all of its branches, except qualifiedly as to military and naval engineering, where in some cases cost may be ignored. In other words, the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically.

For example, a railroad may have to be carried over a gorge or valley. Obviously, it does not need an engineer to point out that this may be done by filling the chasm with earth, but only a bridge engineer is competent to determine whether it is cheaper to do this or to bridge it, and to design the bridge which will safely and most cheaply serve, the cost of which should be compared with that of an earth fill. Therefore, the engineer is, by the nature of his vocation, an economist. His function is not only to design, but also so to design as to insure the best economical result.

He who designs an unsafe structure or an inoperative machine is a bad engineer; he who designs them so that they are safe and operative, but needlessly expensive, is a poor engineer, and, it may be remarked, usually earns poor pay; he who designs good work, which can be executed at fair cost, is a sound and usually a successful engineer; he who does the best work at lowest cost, sooner or later stands at the top of his profession, and usually has the reward which this implies.

Perhaps the most difficult question to determine in selecting a motor outfit is whether to have individual or group driving. The percentage of time that a machine is in operation is an important consideration in the choice between individual and group driving. It would seem that as this percentage increases, the more should the case be treated by grouping like machines together, provided that the speed variations desired are not excessive and sudden. Thus, a group of drill grinders constantly used, and with but few changes in speed, are preferably operated from a single motor through a short line shaft, but machines of the shaper and planer types, boring mills, and in some cases drill presses, may usually be profitably driven by individual motors.



A SECTIONAL PERSPECTIVE OF THE WILKINSON STOKER

THE ELECTRICAL AGE

Volume XXXV Number 4
$2.50 a year ; 25 cents a copy

New York, October, 1905

The Electrical Age Co.
New York and London

ESTABLISHED 1883

Published monthly at 3, 5 and 7 W. 29th Street, New York City.
Telephone No. 1617 and 1618 Madison Square. Private branch exchange connecting all departments. Cable Address—Revolvable, New York.

SUBSCRIPTION RATES

The Electrical Age will be sent post free anywhere in the United States and its possessions, Canada and Mexico for $2.50 per year, single copies 25 cents. To Great Britain and all countries embraced in the postal union, $5.00, 20 shillings, 25 francs, 20 marks, or 15 rupees. Send subscriptions to our nearest branch office or agency.

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Insertion of new advertisements or changes of copy cannot be guaranteed for the following issue if received later than the 15th of each month.

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Business Department, 33, Bedford Street. Editorial Department, 22, Henrietta Street. Covent Garden, Strand, W. C.

London Telephone, Post Office, 3807 Central. Private branch exchange. London Cable Address—Revolvable, London.
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Leading Articles

A New Housing Plan for Skilled Workmen

ONE of the most far-reaching projects ever set on foot by an industrial corporation for the betterment of the conditions of living of its employees has just been made public by the General Electric Company at its works at Lynn, Mass. The plan embraces a comprehensive scheme for the housing of about 7000 employees in individual homes, for the purpose of securing a permanent and contented force of the most efficient skilled workmen. The company proposes to buy land, build cottages of six rooms, and sell them to its employees upon terms that will be as easily met as the rents which they now pay. The company will limit the cost of the land to $400 and of the house to $1800. The buyer will pay for the property at the rate of $4 per week, which is estimated as sufficient to cover interest, taxes, insurance and water rates, and in eight years the occupant will own his home.

It is also stated that the company will, in the meantime, give a life insurance to the subscriber for a fixed amount, and if the subscriber should die before the house is paid for, so much of it as is required to pay for the house will be deducted for that purpose, and the house will become the property of the widow or other beneficiaries, who will also receive the balance of the life insurance. The company does not expect to derive any financial profit from this venture, and about $300,000 have been set aside for the inception of the enterprise.

The feeling is often present among workmen that the corporation for which they are labouring cares nothing for their personal welfare, and in some instances this is, doubtless, true. But in industries where the product is the result of highly skilled labour, the trend of the times is certainly toward better things, and there is a growing realization of the mutual dependence of capital and labour upon each other. The pension and wage increase system of the Boston Elevated Railway Company, the company's attitude toward free legal advice and the mutual benefit association of its employees, and the providing of coal for them at cost prices during the anthracite strike, are good examples of the broader policies of these later times.

It may be impossible to recall the old days of close personal acquaintanceship between a workman and his employee under modern conditions of industrial organization, but there is no question that a great deal can be done to improve the surroundings of a force of men numbering even into the thousands, convincing them that their personal welfare is a matter of real consequence to the company. If the Dean of Harvard College can efficiently act as the "guide, philosopher and friend" of six thousand students, there should be no reason why an official of similar qualifications cannot be of immense value in any of the greater industrial establishments. Something of this kind is likely to come before long, if the temper of the century is not misunderstood.

Aside from the influence of the General Electric project upon the employees of the company, the enterprise means much to Lynn itself,—a factory town in which attractive living conditions are not generally apparent. The development of the company's works in Schenectady has been a prominent factor in the civic improvement of that city, which is a far different place to-day from the Schenectady of six or seven years ago. Given the service of an architectural force, which will not countenance the multiplication of hundreds of stereotyped dwellings, the proposition advanced at Lynn is likely to be of lasting benefit to the best life of the community.

American Electrical Machinery for Cuba and Latin America

CENTRAL and South America, more especially Mexico and the Argentine Republic in the northern and southern hemispheres, respectively, are making rapid strides in developing latent resources whether from an agricultural, mining, or railroad standpoint. In line with this progressive movement, actual developments in the application of electricity

for municipal illumination purposes, as well as in the various industrial divisions, together with the possibilities of its unlimited expansion, with resulting demand for electrical machinery and equipment of every variety, are well apace with other lines and equally promising, with regard to the future.

Electrical machinery and supplies are largely supplied to these Spanish-American countries by European nations, Great Britain and Germany having a monopoly in this respect. Consul Dunning writing from Milan, Italy, in his latest report, says that Italian manufacturers and shippers are making a systematic effort to obtain a solid foothold in Latin-American countries, electrical machinery being mentioned as one of the important export interests susceptible of very material enhancement.

There can be no doubt that owing to the slowness of our movements as a manufacturing and exporting nation, especially as regards electrical machinery, and in striking contrast with the systematic efforts made by Germany and Great Britain, much of this export trade, which under normal conditions is within the reach of American manufacturers, is lost to them.

A study of the methods pursued by the average German commercial agent, trader, or consul, will explain why it is that Germany's export interests in almost every line of manufacture are steadily forging ahead. In the first place, the German agent speaks the language of the natives fluently, and in addition to this it is not unlikely that he can speak both French and English equally well, being contented with whatever allotment the fatherland offers him, whether it be in an English, a French or a Spanish-speaking country. He diplomatically humours the whims of possible purchasers, offers attractive credit periods, and by dint of other specious methods usually succeeds in capturing his man, the merit of the articles sold being not infrequently a secondary consideration.

Furthermore, the German has a faculty for gaining the respect and confidence of the powers that be in the country in which he abides, having always in mind the export interests of Germany, while his willingness to enter into social relationship with the better, or purchasing class, of the natives,—matrimonial alliances not being uncommon,—further strengthens his position. To-day the German colony in Mexico is probably held in higher regard by President Diaz and the government of that republic than either the French or Spanish colonies. Twenty years ago British firms were well represented in Mexico City, with branch stores and warehouses in which many manufacturing lines, textile as well as mechanical, were represented. But to-day the German element controls the situation. German electrical machinery is seen on every hand in Spanish-American countries.

An American traveling salesman unacquainted with the Spanish language has a heavy up-hill task under conditions like those just mentioned, notwithstanding the possible and often admitted superiority of American goods. If American firms are to obtain their share of this trade, much of which lies at their doors, it behooves them to adopt methods calculated to produce the desired results. In this respect manufacturers and shippers naturally look to the government for support and co-operation, as much of the future's success depends upon the tact and business ability of the American consul in those countries, in working out plans for export trade developments. These, if not identical with those pursued by German consuls, should at least be of a nature likely to bring about reasonably successful results.

Cuba is an inviting field for manufacturers and exporters of things electrical. There the opportunities are better, and notwithstanding drawbacks in the difference of language, which are yearly becoming minimized, America is well in the lead there as an exporting country, with the prospect of practically controlling the entire island trade in electrical machinery and supplies.

The former secretary of agriculture and public works of the Cuban government, referring recently at Washington to Havana's electric railway system, said that there were 50 miles of railway in operation, and that 120 miles more would be constructed in the near future. Senor Manuel Luciano Diaz, who is vice-president of the Havana system, speaks hopefully of Cuba. The extraordinary progress made there is illustrated by the fact that it is only four years ago since the first electric car was run on the island, yet the gross earnings of the roads last year were more than a million and a half dollars. So far, the company has purchased all its rolling stock from the United States, but there is talk now of putting up a car shop for supplying their future needs. The electric lines are to be gradually extended throughout Cuba. At present these roads have assets of about $21,000,000, their stock being listed on the New York Stock Exchange. American capital is the chief factor in the Cuban electric railroads.

There is a growing demand in Cuba also for electrical equipment for central stations. In this latter respect, however, requirements in Mexico, the Argentine Republic, and Chili are much more extensive, and will continue to be so indefinitely. For power plant possibilities, Mexico probably offers more opportunities than any other country. In the several mining districts, as well as in the mountainous regions in the southwestern and southeastern parts of the republic in which large towns lie scattered, with a superabundance of water power, the need of power, light, and transit offer, for many years to come, a rich field for American capital investment in electrical lines. It seems almost needless to say that where American capital and brains are interested, the trade thereby controlled naturally gravitates to the United States.

Electrical News from Abroad

THE bulk of the consular and trade reports issued by the Department of Commerce and Labour, at Washington, D. C., is of great utility, but occasionally consular agents unwittingly forward information concerning matters that are somewhat out of date.

This, however, it would be difficult to avoid, as it is obviously not feasible for consular agents in all cases to sift what is old or obsolete from what is new and modern. Besides, information of this kind serves to indicate whether it is we or the other man that is just catching up with the procession. For example, United States Consul Mahin, at Nottingham, England, in a recent report, states that a successful automatic fire alarm has been invented in that country. The device, says Consul Mahin, is merely a scientific application of the fact that heat causes expansion. "As soon as the metal in the little apparatus becomes affected by the rise in temperature, which must inevitably take place immediately a fire breaks out, it expands, completes an electric circuit, and a bell, which may be placed anywhere—at the fire station if desired—rings. These instruments are attached to the ceiling, where the change of temperature is most quickly felt. Experiments made in England warrant the belief that this automatic alarm will prove of great value in preventing the spread of fires."

The reader will recognize in the foregoing a description of the well-

known electric thermostat, or electric valve, of which thousands have been in practical operation in America for twenty or twenty-five years, on automatic fire alarm telegraphs. This, as has been intimated, is rather a late day to bring out this device as a novelty. But perhaps it is a novelty in Great Britain where the adaptation of electric fire alarm methods have been of slow growth.

One type of a widely used electric thermostat on the market for many years, consists of a light bimetallic spring, made of steel and copper strips bent normally into the shape of a crescent. The more expansive of the two metals under heat, namely, the copper, is placed on the outside of the spring. One end of the spring is securely fastened to a support on a small papier maché disk, while opposite its free end is placed an adjustable platinum point. When the spring is subjected to heat, it tends to coil into a smaller crescent, but its motion is stopped by the platinum point completing an electric circuit, thereby giving an alarm.

Another recent report, forwarded from Germany by Consul-General Guenther, relates to the inventor of the telephone and gives a quotation from a Frankfort newspaper, which states, as though it were a new discovery, that the telephone was described in all its parts by the French mathematician, Charles Bourseul, in 1854. If there is any one thing in telephony that has been thoroughly threshed out and decided by the courts and by Bourseul's contemporaries, it is that he did not invent the speaking telephone. There is no reasonable doubt that Bourseul was the first to predict the possibility of the electric transmission of speech, and indicated the means by which it might be accomplished. He wrote in an article which was reproduced in numerous periodicals in 1854:—

"We know that sounds are made by vibrations, and are adapted to the ear by the same vibrations which are reproduced by the intervening medium. * * * Suppose that a man speaks near a movable disk, sufficiently flexible to lose none of the vibrations of the voice, that this disk alternately makes and breaks the currents from a battery; you may have at a distance another disk, which will simultaneously execute the same vibrations."

Bourseul, however, published no description of the actual manner in which he would accomplish this result. Indeed, even after twenty-two years, Bourseul did not obtain this result, and it remained for Graham Bell, in 1876, to effect the electric transmission of speech, not by alternately making and breaking the currents from a battery, the method unsuccessfully adopted by M. Reiss, following, in 1860, Bourseul's suggestion,—but by producing in an electric circuit undulations of current corresponding to the air waves set up by the voice.

Bourseul's idea was admitted to be a magnificent one, but as Count Du Moncel wrote in 1879, "There is nothing in his (Bourseul's) paper to show what were the means he proposed, so that the discovery of the electric transmission of speech cannot reasonably be ascribed to him, and we (Du Moncel) do not understand why we should be reproached for having at this time (1854) failed to appreciate the importance of a discovery which seemed to be then only within the range of fancy."

Thousands of people have predicted that when we can approximate the methods and conditions employed by birds in flight, we shall be in a fair way to obtain aerial navigation. Thus far no one appears to have been able to bring about the necessary method and conditions for this purpose. No doubt some day this much-desired result will be an accomplished fact. It is not too much to say, however, that at present the gulf which divides the existing human methods of aerial flight from that of the birds of the air is no wider than that which divided the method proposed by Bourseul for the electric transmission of articulate speech, from the method by which the art of electric telephony was finally established. The difference in brief was that which exists between failure and success.

Electric Transportation on the New Haven Railroad

ONE of the most significant announcements in the history of electric transportation was that made public at the Philadelphia convention last month of the American Street Railway Association by C. F. Scott, of the Westinghouse Company, in a paper entitled "The Single-Phase Railway System." In connection with the development of electric suburban service by the New York Central Railroad in the vicinity of the city of New York, it has for some time been known that the New York, New Haven & Hartford trains entering the Grand Central Station were to be electrically operated, but the character of the equipment to be used was in doubt. The choice of single-phase alternating-current electric locomotives for this work is, therefore, a most important and interesting matter, particularly in view of the Central's selection of direct-current machinery.

The New Haven locomotives are designed for high-speed passenger service and will weigh about 78 tons each. With a 200-ton train in local service, making stops every 2.2 miles, each locomotive will be capable of maintaining a schedule speed of 26 miles an hour, attaining a maximum speed of 45 miles an hour between stations. A speed of from 60 to 70 miles an hour can be maintained in express service with a 250-ton train, while heavier trains can be operated at the same range of speed by coupling two or more locomotives together upon the multiple-unit plan, controlling all the motors from one cab, in the manner employed in high-speed elevated and interurban service.

A great advantage of the new machines, and in fact one without which they would be useless on the New York Central tracks between Woodlawn and the Grand Central Station, is their adaptability to either alternating or direct-current service. Each locomotive will be equipped with four of the Westinghouse Company's single-phase commutating type gearless motors, permanently connected two in series. When operating with direct current the pairs of motors will be run in series parallel combinations, and with alternating current circuits voltage control will be used. Each motor will be capable of developing 400 rated horse-power. The cost of each locomotive is said to be $30,000, three-quarters of a million dollars covering the first contract for twenty-five machines.

Probably the first question which arises in connection with such a radical and brilliant departure from previous practice is the reason why alternating equipment was adopted in preference to direct-current machinery. It seems but a few short months since the published particulars of the superb locomotives which the General Electric Company is building for the New York Central road illustrated the climax of electric railway evolution. The advisory engineers of the Central road investigated the problem of suburban traction with unusual thoroughness and established the conclusion that where the traffic is dense, in suburban and terminal work, the direct-current system solves the problem without the necessity of breaking too far away from previous experience and introducing those uncertainties which cannot for a moment be tolerated in the operation of a great trunk-line system.

The New Haven's choice of alternating-current locomotives does not in the least question the wisdom of the New York Central decision, bearing in mind the conditions prevailing at the time of its being made known, but it does furnish a remarkable evidence of progress in the evolution of electric locomotives, and it signifies beyond the shadow of a doubt that in the minds of the New Haven engineers the final solution of the problem of heavy transportation lies in this direction. Although the alternating locomotives will for the present be operated only upon the direct-current system between Woodlawn and New York, they provide immediate means of pushing the electrified train service as far into Southern New England as the policy of the road may dictate, and it certainly requires no very great imagination to predict the ultimate operation of high-speed through trains between New

The subject of electricity upon steam railroads has been so actively discussed of late years that it is needless in these comments to emphasize the advantages which the newer motive power offers. But as the problem of trunk-line transportation is in many quarters regarded as the prize question to be solved by electric railway engineers, it is interesting to consider the peculiar fitness of the alternating-current locomotive for the work and the reasons why the New Haven unit may be considered the most dangerous rival to the steam locomotive that has thus far appeared.

There is no doubt that the substitution of electricity for steam in suburban service will often lead to heavy expenditures in connection with the abolition of grade crossings, improvement of track layouts and reconstruction of terminals,—items which must all be considered in addition to the cost of replacing the steam equipment with power houses, distributing systems, and motor-driven rolling stock. In the absence of actual operating figures from electrified steam railroads in commercial service—omitting elevated lines—it is open to some question whether the change to electricity is always justified solely on the ground of reduced operating expenses. The matter wears a different aspect, however, when one considers the vast improvements in service and consequent increase in traffic which electricity is sure to bring.

The day is in sight when the steam locomotive will not be tolerated in metropolitan terminal service; and on mountain divisions and other sections of the line hampered by long, heavy grades and sharp curves, the electric locomotive offers a favourable method of relieving congestion and performing the heavy service far better than is possible with a steam locomotive, which cannot be built to anything like the same power output as the electric machine under present conditions of tunnel cross-section, bridge clearances, and track capacity. The New Haven unit's rated output equals 1600 H. P.; at even moderate overloads this will considerably exceed the capacity of the largest sizes of steam locomotives, and the concentration of power made possible by the multiple-unit design fits the machine for anything likely to be required in railroad service without the addition of an engineer and fireman for each unit operated in a given group.

Thanks to its direct-current characteristics, the New Haven locomotive permits the enjoyment of practically all the suburban service improvements which the New York Central machines assure, but the fundamental solution of the long-distance problem lies in the inherent advantages of high-tension transmission and distribution plus the elimination of the complex sub-stations, heavy cables, increased attendance, and sometimes troublesome rotary converters common to the direct-current locomotive supply system. The three-phase system may still be used for transmission economy; power houses and sub-stations can be spaced much farther apart than in direct-current practice, and moving apparatus is unnecessary in the latter. The high-voltage trolley has been proven simple, strong and practicable up to at least 3300 volts, while effectiveness and freedom from complication are assured in the controlling mechanism.

The adaptation of the multiple-unit system to alternating-current requirements is a notable step in advance, but the crowning achievement is the design of a 400-H. P. single-phase motor in the face of obstacles, which, until recently, were full of the gravest difficulty.

It will be interesting to watch the parallel development of heavy electric traction upon the New York Central and the New Haven systems, and the next few years promise valuable experience in this suburban work. President Mellen and his associates are certainly to be congratulated upon the progressive policy which they have inaugurated, and no less praiseworthy are the labours of the large electric manufacturing companies who are sparing no expense to meet the intensified demands of the twentieth century traffic manager.

Progress of the Aluminium Industry

During the year 1904 the Pittsburg Reduction Company, the only producer of aluminium in this country, improved its plants at New Kensington, Pa.; Niagara Falls, N. Y.; East St. Louis, Ill.; Bauxite, Ark., and Shawinigan Falls, Quebec. The prosperity in the aluminium industry has been shared also by the Royal Aluminium Company, Shawinigan Falls, Quebec, Canada; the British Aluminium Company, with works at Foyers, Scotland; the Société Electro-Metallurgique Française of Le Praz, Savoy, France; the Compagnie des Produits Chimiques d'Alais of St. Michel, Savoy, France, and the Aluminium - Industrie - Aktien - Gesellschaft of Neuhausen, Switzerland; Rheinfelden, Baden, Germany; and Lend Gestein, near Salzburg, Austria.

The processes employed are the Hall in the United States and Canada, the Hall and Minet and the Héroult in France and the Héroult in Switzerland, Germany, and Austria. A departure of some interest is the attempt to utilize the extensive deposits of bauxite at Leece, Italy, and the water falls of Pescara to generate electric power for the purpose of manufacturing aluminium. It is understood that Italian and German capital has become interested in this new enterprise.

According to an article in the "Schweizerische Bauzeitung" on "Large Modern Turbines," by L. Zodel, chief engineer of the well-known Swiss firm Escher, Wyss & Co., of Zürich, no turbine above 250 H. P. had been made until 1875, whereas now they are built of over 10,000 H. P. In 1900 the firm built turbines of 5500 H. P. for the Niagara Falls Power Company; in 1901 some of 3000 H. P. for Glommen near Christiania, and subsequently units of 6000 H. P. and 10,000 H. P. for the Canadian Niagara Falls Power Company, the latter being the largest yet built.

One hundred and twenty-nine motor cars were imported into the Argentine Republic in 1904, an increase of sixty-seven over 1903. The demand will continue to increase, as they have been used successfully on the country roads. One car successfully crossed the Andes. They are being imported for the use of the post-office, and fire brigade and city ambulance service.

Electrical and Mechanical Progress

New Electric Railway Motors

HEAVIER rolling stock and faster schedules in electric traction have from time to time necessitated the production of larger motors for elevated, subway, interurban, and suburban service. Of the most recent designs brought out by the Westinghouse Electric & Manufacturing Company, of Pittsburg, illustrations are here given. The smallest of the new motors has a capacity of 75 H. P., and the largest, one of 200 H. P. Between these two there are a number of other sizes.

Among the special claims made for the new motors may be mentioned the diagonally divided field frame for making every part accessible; the gear case supported entirely at the ends for avoiding the side strains; housings for armature bearings clamped between the two halves of the frame; generously proportioned bearings with an effective system of lubrication; armature and commutator assembled upon a single spider; bar-wound armature with split coils; commutators with many bars; low current density in the brushes; bolted-in laminated poles; sealed field coils wound with strap; excellent commutation; high efficiency; low operating temperature, and great mechanical strength.

Limitations are naturally placed on the size and construction of a motor by the amount of available space on the truck of the car; therefore, the frame of square cross section has been adopted as utilizing this space most advantageously. All these new motors have cast-steel frames split at an angle of 45 degrees with the horizontal. The axle bearings are carried by the lower half of the field frame and are divided at an angle of 35 degrees with the perpendicular, so that the weight of the motor may be supported almost entirely by the part of the frame extending over the axle rather than by the axle-cap bolts. By lifting off the upper half of the field casting, the armature may be removed from the frame without taking the motor from the truck; or the motor may be removed from the truck by simply taking off the gear case and axle caps. Three bales are located so as to make the handling of the motor easy. Bolts with nuts and lock washers hold the two halves of the frame together, and the axle caps in their proper position.

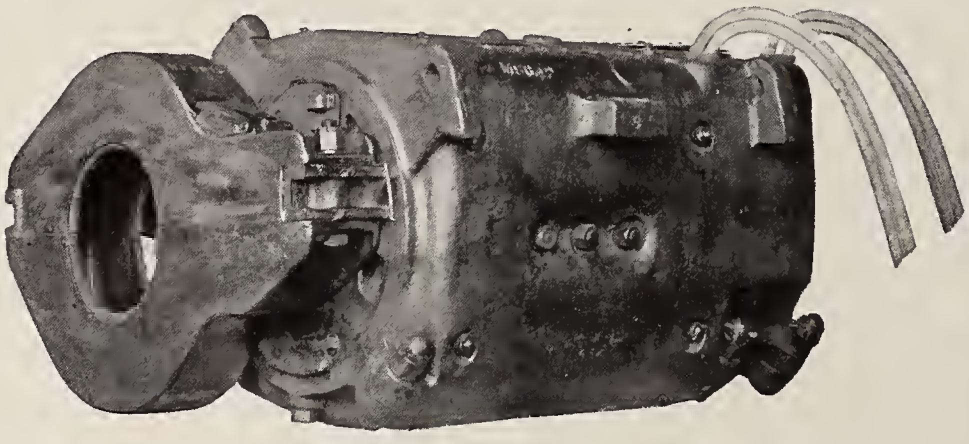


FIG. I.—A 200-H. P. RAILWAY MOTOR BUILT BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURG, PA.

Housings for the armature bearings are circular in form and are turned slightly larger in diameter than their seats in the frames, so that when clamped in place all the advantages of a press fit may be obtained.

FIG. 2.—ARMATURE OF THE WESTINGHOUSE RAILWAY MOTOR SHOWN IN FIG. I

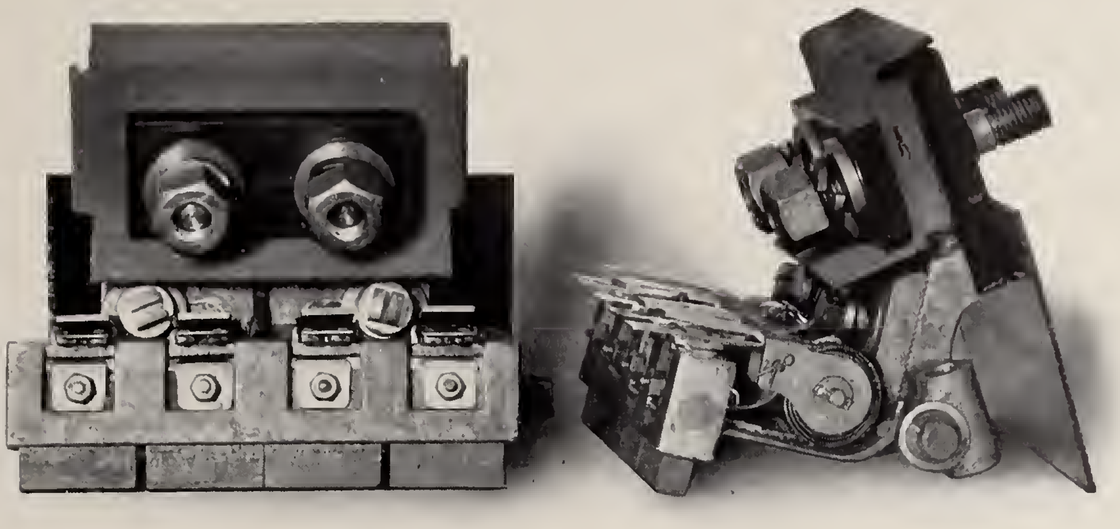


FIG. 3.—BRUSH HOLDERS OF THE WESTINGHOUSE RAILWAY MOTOR SHOWN IN FIG. 1

Finished shoulders on the housings are claimed to prevent any lateral movement and to take the entire end thrust of the armature instead of imposing this severe strain on the clamping bolts. Two bolts through the frame at each end prevent the housing from turning.

The armature bearings are made of solid phosphor-bronze bushings, finished all over with a 3-32-inch lining of babbitt metal. If, from neglect, the bearings should become so hot as to melt the babbitt metal, the armature would be supported on the brass shell and, it is said, would not strike the poles. Both oil and waste lubrication are provided. The waste comes in contact with the bearings on the low-pressure side, and is supplied with oil from separate pockets from below; in this way it is filtered before reaching the bearing. The amount of oil in the reservoirs may be gauged so that it may be kept at the proper level for economical service. With intelligent care, it is stated that these bearings will run 100,000 to 150,000 miles.

The axle bearings are similar in construction to those of the commutator, except that split bushings are used. Here, also, lubrication is by means of oil and waste, the oil being supplied from below.

Pole pieces, built up of punchings of soft steel, are bolted to the top, bottom, and sides of the motor frame, and being almost square in cross section permit the use of flat field coils. These coils are wound of copper strap, insulated between turns with treated asbestos ribbon, and then taped and given repeated dippings in specially prepared insulating compounds and varnishes; this, it is claimed, makes them moisture-repelling and able to stand internal heat. Brass hangers hold the coils in place independently of the poles.

The armature core is built up of steel punchings keyed on a cast-steel spider, which also carries the commutator. The shaft is forced into the finished armature and keyed to it, and may be removed, should necessity arise, without disturbing the windings or commutator. The armature coils are strap wound and made in two parts. As the top coils are more liable to injury, this design is claimed to make possible the removal of the damaged part without disturbing any other part of the winding. The coils are insulated with mica, and are sealed and further insulated by dipping in varnishes which are said to be oil-proof and moisture-repelling. On each end, the armature slots are made deeper and wider, thereby providing space for mica cells to reinforce the insulation at these points. As a further protection, fibre strips are taped to the upper sides of the top coils. A bell-shaped flange at the pinion end and a cylindrical flange on the commutator end form supports for the windings. Countersunk bands of steel wire on the core and wide bands outside the core hold the coils in position. Openings through the spider and core allow the passage of air which is thrown forcibly against the field coils for maintaining a low temperature throughout the motor.

The commutators are made from a great number of hard-drawn copper bars with short necks, insulated from each other and held between insulated V-rings.

The brush holders are of the sliding type, with springs of phosphor-bronze held in a harness which definitely fixes the radius of action of the spring tip. The tension of the spring may be adjusted without removing the holder from the motor. The brush holder proper is bolted to an insulated guide and may be removed without disturbing the insulation or connections. Leads of flexible rubber-covered cable, which are said to be flame-proof, are brought out at the front of the motor over the commutator through insulating bushings. Access to the brushes and brush holders is provided through a large opening in the frame over the commutator which extends well down the side. A hole in the rear end bell, and an opening under the commutator provide means for inspecting the clearance between the armature and field poles.

The steel pinions used on these motors are held on to tapered seats by keys, nuts, and lock washers. The gear cases are divided along the center line of armature and axle, and are supported only at the ends; this construction is claimed to do away with all side strains. Nose suspension with safety lugs is used for all motors of this design.

A Series Alternating-Current System of Arc Lighting

THE Fort Wayne Electric Works, of Fort Wayne, Ind., have recently developed a system for series arc-lighting circuits which may readily be operated upon a constant-potential supply.

The system has been designed for a frequency of either 60 or 140 cycles, and consists of a regulator for maintaining a constant current, a specially designed high-tension switchboard, a constant-potential transformer, and a series of arc lamps. In addition, both sides of the line are equipped with a lightning arrester.

Fig. 1 represents the type of regu-

FIG. 1.—THE REGULATOR MADE BY THE FORT WAYNE ELECTRIC WORKS, FORT WAYNE, IND., FOR THEIR SERIES ALTERNATING-CURRENT SYSTEM OF ARC LIGHTING

lator which has been designed for this system. Its operation depends upon the automatic introduction of impedance into the lamp circuit whenever any decrease in the resistance of the latter would tend to cause an excessive current to flow. This impedance is introduced by the combined movements of a laminated iron core and impedance coil into such a position as to cause a greater magnetic flux to be cut by the current in the coils. This increase in the amount of flux cut by the line current produces a choking effect, reducing the latter to its normal value. If, for any reason, the line current be decreased, the exact opposite effect takes place within the regulator, and the current is automatically increased to its normal value.

FIG. 2.—THE CONSTANT-POTENTIAL TRANSFORMER USED IN THE FORT WAYNE ARC LIGHTING SYSTEM

The mechanical parts of the regulator are counterbalanced so that the motion of the heavy core is small as compared with that of the coil. This design, it is claimed, reduces the inertia and guarantees a sensitive adjustment of the current; it also permits the core and the coils to counterbalance each other, and does away with the use of the counterweight.

This regulator requires a floor space of 22 inches by 28 inches in the 75-light capacity, and may be located upon the floor of the power station in any convenient position. It is stated that no attention is required at the regulator, the starting operation being entirely controlled from the switchboard, which is specially designed for this purpose.

The switchboard furnished with this system consists of a single panel of blue Vermont marble, equipped with ammeter, reactance, fuses, and all the necessary switches for starting and operation of the system. It can be furnished with or without a wattmeter sub-base equipped with an integrating wattmeter. Fig. 3 shows the front of the switchboard for use with step-up transformer and integrating wattmeter.

By reference to the accompanying diagram, Fig. 4, the peculiar design will be noted by means of which, it is claimed, the system may be quickly started from the switchboard without paying any attention to the regulator and without causing any excessive rush of current through either the regulator or the lamps. The starting switch, located in the center of the panel, should always be closed last. In the closing of this switch, there are the three following stages:—

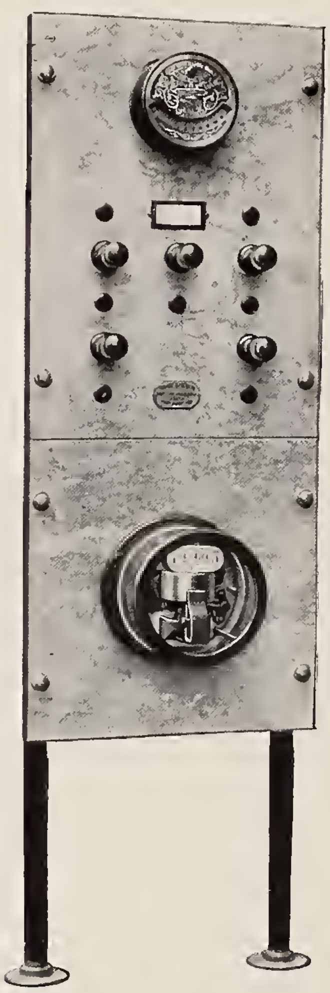


FIG. 3.—THE SWITCHBOARD USED IN THE FORT WAYNE ARC LIGHTING SYSTEM

At the first stage, a reactance, mounted upon the back of the switchboard, is introduced into the regulator circuit, so that no rush of current will take place when the regulator is thrown upon the line. If it were not for the introduction of this reactance, the regulator, which is in its no-load position, would introduce but very little impedance in the circuit and would permit an excessive current to flow. With the introduction of the reactance, however, the current is choked down to its normal value until the regulator comes to its full-load position, in which position it introduces a sufficient impedance of its own to reduce the current to its normal value.

The second stage in the closing of the starting switch short circuits the above reactance, thus throwing the regulator, which has now reached its full-load position, directly across the constant potential bus-bars. During both these stages, the line leading to the arc lamps is short circuited.

When the starting switch is entirely closed, the short circuit across the line which previously existed is removed, thus permitting the line of arc lamps to operate in series with the regulator upon the normal current. It is said that by thus connecting the lamps in circuit after normal current has been maintained, no disturbance is caused in the mechanism of the lamps.

Although the systems for 12 and 25 lights will operate satisfactorily without the use of a constant-potential transformer upon circuits of 1100 and 2200 volts, respectively, it is advisable to use a transformer in all cases, although it may be of 1 to 1 ratio, introduced merely for insulation purposes. This is especially desirable where both arc and incandescent systems are operated from one

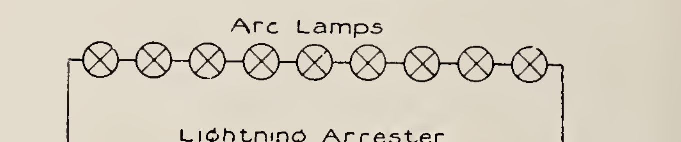


FIG. 4.—CONNECTIONS FOR THE FORT WAYNE SERIES ALTERNATING-CURRENT SYSTEM OF ARC LIGHTING

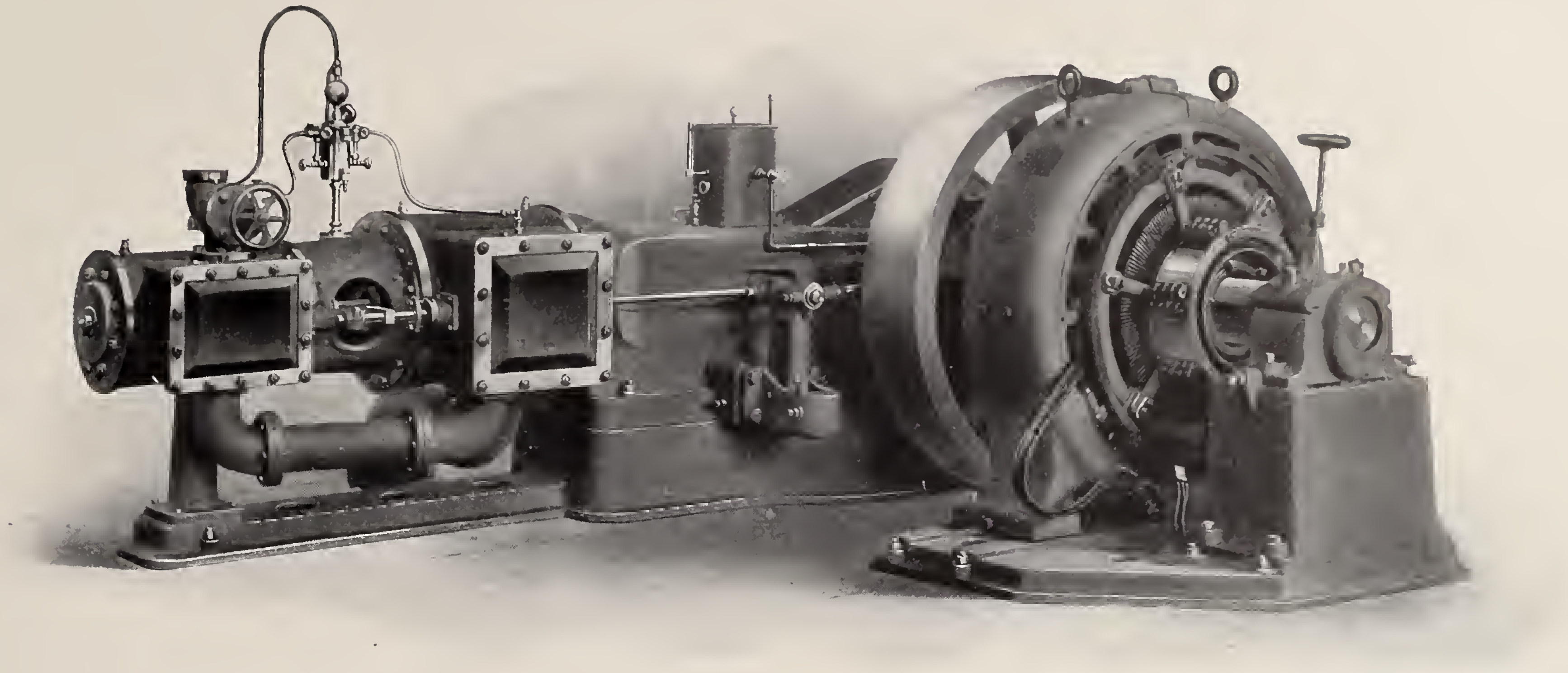


FIG. I.—A HORIZONTAL TANDEM COMPOUND SIDE-CRANK ENGINE OF THE DIRECT-CONNECTED, SINGLE-VALVE TYPE. BUILT BY THE BALL ENGINE COMPANY, ERIE, PA.

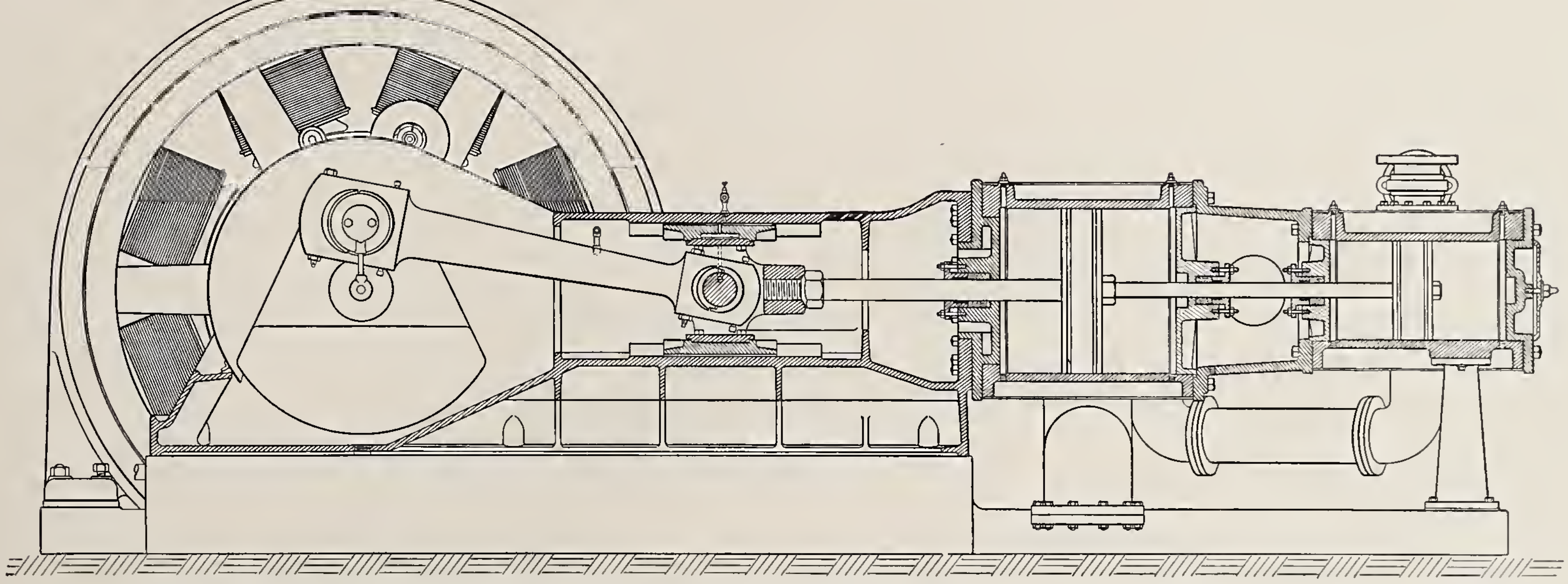


FIG. 2.—A LONGITUDINAL SECTION

set of bus-bars, in order to entirely insulate the arc system from that which supplies the incandescent lamps.

Fig. 2 shows a constant-potential transformer supplied with this system which may step up or step down the bus-bar voltage, or maintain the same voltage upon both primary and secondary in cases where it is introduced for insulation purposes only. The secondary of this transformer is provided with a number of taps, by the use of which the output of the station may be varied as more arc lamps are needed upon the circuit, so as to maintain at all times practically full-load efficiency and power factor. If, therefore, a regulator and transformer be purchased of sufficient capacity to meet the needs of a growing system, the latter may be connected at first so as to supply only a small portion of its total output, and, as the number of arc lamps increases, the taps upon the transformer may be so connected as to meet this demand with no further cost of installation. This may be done, it is claimed, with practically no sacrifice of efficiency when operating the circuits of small capacity.

The alternating-current series arc lamps designed to operate in connection with this system need but one trimming in 125 hours, when adjusted for normal current of 6.6 amperes.

A New Direct-Connected Steam Engine

A NEW horizontal tandem compound side-crank steam engine of the direct-connected, single-valve type built by the Ball Engine Company, of Erie, Pa., is shown in section and perspective in two accompanying illustrations.

This engine has but two shaft bearings, and means are provided for testing their alignment at any time. Two projections are cast on the frame, one at either side of the main bearings and just behind the crank. These are planed off on a line exactly parallel with the center line of the cylinder. A boss is formed on one side of the crank disc and a gauge is furnished which can be attached to this boss and set to one of the planed projections referred to; then, by turning the crank half-way over and keeping all end play of shaft in one direction, the gauge will be brought opposite the other projection. If the engine is in line it will show alike on two surfaces, or if there is any misalign-

ment, such will be clearly indicated.

The crosshead is provided with babbitt-faced shoes. The pin is not flattened top and bottom, but instead is so arranged that when it wears oval it can be turned through one-fourth of a revolution, thus giving it a new surface for wear.

In the governor the centrifugal force of the weight is resisted directly by a spring and is not transmitted through any bearings. The speed is raised or lowered by changing the tension of the spring. The sensitiveness is controlled by moving the link which connects the weight and the eccentric, in or out along the row of holes provided for that purpose. These two adjustments, one controlling the speed and the other the regulation, are positive in action, easily made, and permanent when made.

Single-valve engines of the type shown in the illustrations are built in sizes ranging from 50 to 700 horse-power.

A New Form of Conduit Rod

A NEW automatic wheel conduit rod made by the Diamond Expansion Bolt Company, of New York, is shown in the annexed cut.

It is claimed that these rods can be coupled or uncoupled instantly, that they will not buckle or form a zig-zag line when pushed through the conduit, and that they are flexible when pulled, thus allowing considerable variance when crossing a manhole, and making it easy to enter another duct out of line with the first. The rods become rigid again when pushed into the new duct.

It is said to be impossible for the rods to become detached while in a duct, as the rear end of a 3-foot rod must be raised 20 inches, or to an angle of 45 degrees, before it can be uncoupled.

The wheels on the rod are claimed to serve the following purposes:—

1. They prevent the rods coming into contact with the walls or floor of the duct, eliminating all friction and wear, and enabling one man to push with ease a set of rods 600 feet long.

2. They serve as a duct cleaner, each pair of wheels bringing out a quantity of dirt or mud as they emerge from the duct or pass through the manhole. In removing the obstructions, a very hard blow can be struck with telling effect on these rods without the least injury to them.

3. The wheels insure a 2½-inch duct opening throughout the entire section length, thus allowing a cable of that dimension to be installed.

4. The wheels are so shaped that they pass along easily so long as no obstruction narrowing the duct to less than 2½ inches is encountered.

The couplings are made of bronze or malleable iron, the wheels of chilled cast iron, and the rods of the very best hickory. A record of 20,915 feet by two men in 8 hours is claimed to have been made with these rods.

A NEW WHEEL CONDUIT ROD MADE BY THE DIAMOND EXPANSION BOLT COMPANY, NEW YORK

It is stated in the London "Times" that a Swiss expert, Edmund Allo, has presented to the Parliament of New Zealand a report dealing with the electrification of railways in that colony. This engineer proposes two alternatives, viz., continuous-current traction with high-tension three-phase distribution and rotary converter sub-stations on the one hand, and three-phase traction with transformers along the line on the other hand. The railways in question have a gauge of 3 feet 6 inches, and the cost of providing the overhead equipment and bonding the rails is estimated at $1500 per mile. Locomotives are suggested with two 128-H. P. motors, and a high-tension distribution voltage of 50,000 volts. Water power is to be employed for generating purposes.

Magnetic Switch Controllers for Heavy Ore Unloading Machines

ONE of the most interesting and notable examples of the remarkable advance in modern industrial appliances is that to be found in the ore-unloading equipment of the Great American Lakes. A notable type of modern equipment employed for the purpose is the Hulett automatic ore unloader, invented by George H. Hulett, third vice-president of the Wellman-Seaver-Morgan Company, Cleveland, Ohio, who are sole builders of the machines.

The general view given in Fig. 1 shows the latest installation of these unloaders, namely, two electrically-operated machines at the United States Steel Corporation's Lorain Steel Company's docks, at Lorain, Ohio. An idea of the heavy service required of these machines may be gathered from the fact that they rapidly handle an enormous grab bucket, which, when open, has a spread of over 18 feet, and which automatically digs and conveys from the hatches of the boat 10 gross tons of iron ore at a load. This bucket, when open, can, by telescopic motion, be extended still further, so as to reach more than half way from the center of hatch to hatch. It is carried at the lower end of a vertical dependent leg suspended from a long pivoted beam, carried on a carriage or trolley, which travels back and forth on the girders of the machine.

The operator, who controls all the motion of the bucket, rides at the lower end of the leg directly above the bucket. By means of hoisting mechanism, the walking beam is made to oscillate up and down, carrying the bucket down into the hold of the boat and up again above the dock. The leg carrying the bucket is mounted on rotating trunnions in the walking beam so that it can rotate in a circle when operating in the hold of the vessel, permitting the bucket to reach out in all directions. It also travels lengthwise of the hatch, to the sides of the boat; consequently, the operator is able to reach almost the entire cargo.

The travel of the trolley back and forth on the girders carries the walking beam with the bucket out over the boat and back over the dock. To reduce the trolley travel as much as possible, suitable hoppers for receiving the contents of the bucket are mounted between the girders at the front; these hoppers discharge into an auxiliary bucket car.

The Hulett unloaders at Lorain are provided with cantilever exten-

FIG. I.—GENERAL VIEW OF HULETT UNLOADERS BUILT BY THE WELLMAN-SEAVER-MORGAN COMPANY, CLEVELAND, OHIO, ON THE DOCKS OF THE LORAIN STEEL COMPANY, LORAIN, OHIO

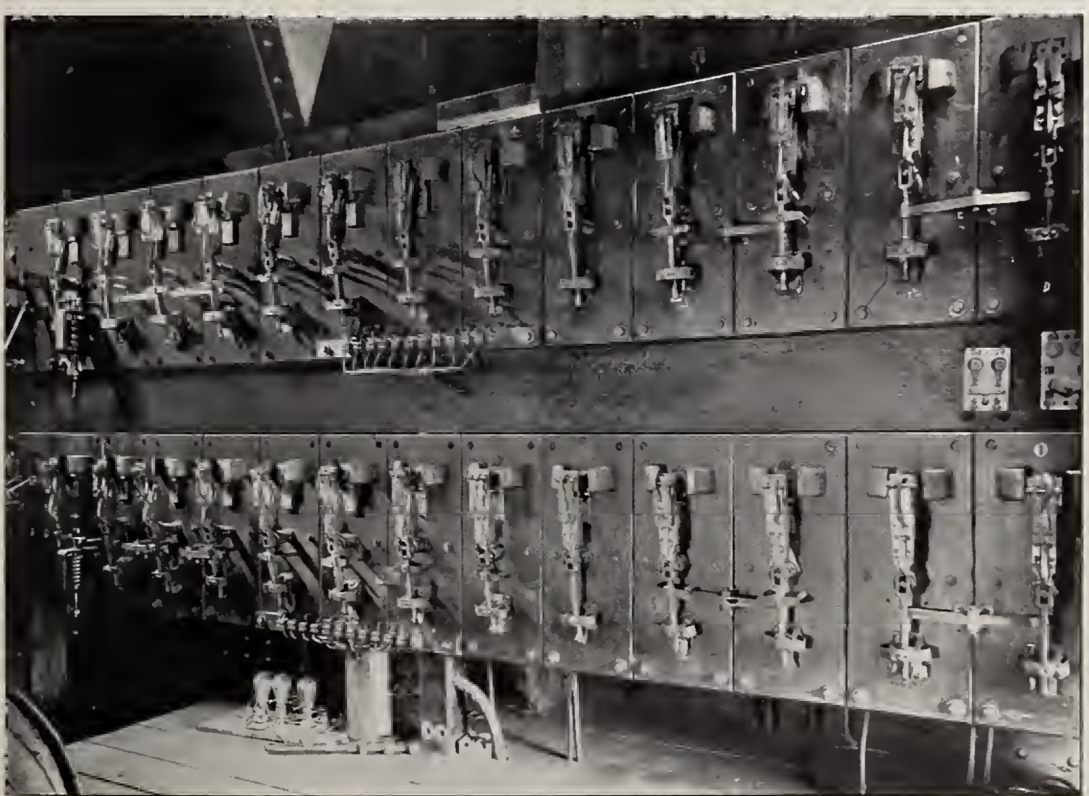


FIG. 2.—MAGNETIC CONTROLLER FOR THE MOVEMENT OF THE BUCKET UP AND DOWN, AND IN AND OUT OF A BOAT. DESIGNED AND MADE BY THE ELECTRIC CONTROLLER & SUPPLY COMPANY, CLEVELAND, OHIO

sions, designed particularly for delivering the ore on a high bank back of the machines. The bucket car travels on these cantilever extensions, automatically dumping the ore at any desired point and returning closed to its position under the hopper. The entire machine is mounted on moving trucks, enabling it to travel up and down the dock from hatch to hatch without moving the boat.

The whole operation is by electric power. The controllers proper, for the unloader, consist of a number of magnetically-operated clapper switches, which cut resistance in and out of the motor circuits. The switches are operated by solenoids placed on the back of the switch panel. The main contact of each switch is a heavy laminated copper brush reinforced with a brass contact, the final break taking place between carbon contacts, and the arc is quickly broken by a powerful magnetic blow-out. The switches are

controlled by small master switches located in the operators' cabs. As the solenoids of the switches require but few amperes, the wires connecting the master switch with the controller proper are of very small size.

Each motion of the unloaders is protected by a positively connected or geared automatic cut-out or emergency switch. The cut-outs for the hoist and bucket car motions automatically slow down and stop these motions as the limits of travel are reached. They first operate to gradually introduce resistance and slow down the motor; they then change connections to convert the motor into a generator, and apply a gradual dynamic braking effect until the motion is nearly stopped; and finally they apply band brakes.

This application of dynamic braking to these motions is claimed to be of particular advantage, as the energy of the heavy parts is absorbed and dissipated in the resistance, thus removing practically all wear from the solenoid band brakes. Under these conditions the band brakes operate as holding brakes, and are required to stop the motion only upon failure of current supply.

The bucket rotation and trolley motions are supplied with geared automatic slow-down and cut-out devices, which gradually insert the resistance and finally apply solenoid band brakes to stop the motion as the limits of travel are approached. While all of these automatic devices are claimed to fully protect the machinery and motors against failure of current supply, confusion and faults of the operator, still they allow the operator full control of the motors at all times, with the exception that he is unable to pass a predetermined limit of travel of the motions.

The main controllers are located near their respective motors, so that the heavy wires carrying large currents are short. The master switches, or controllers, are made small, so that all operating handles can be brought within easy reach of the operator.

The magnetic controllers, which control the movement of the bucket in and out of the boat, and the raising and lowering of this bucket, are shown in Fig. 2. To the left are seen four pairs of two switches each, interconnected by means of horizontal levers. These are the reversing switches, and the function of the levers is to prevent the closing of both reversing switches at the same time. To the right are seen three switches, interconnected by means of two levers. The function of these levers is to prevent the closure of

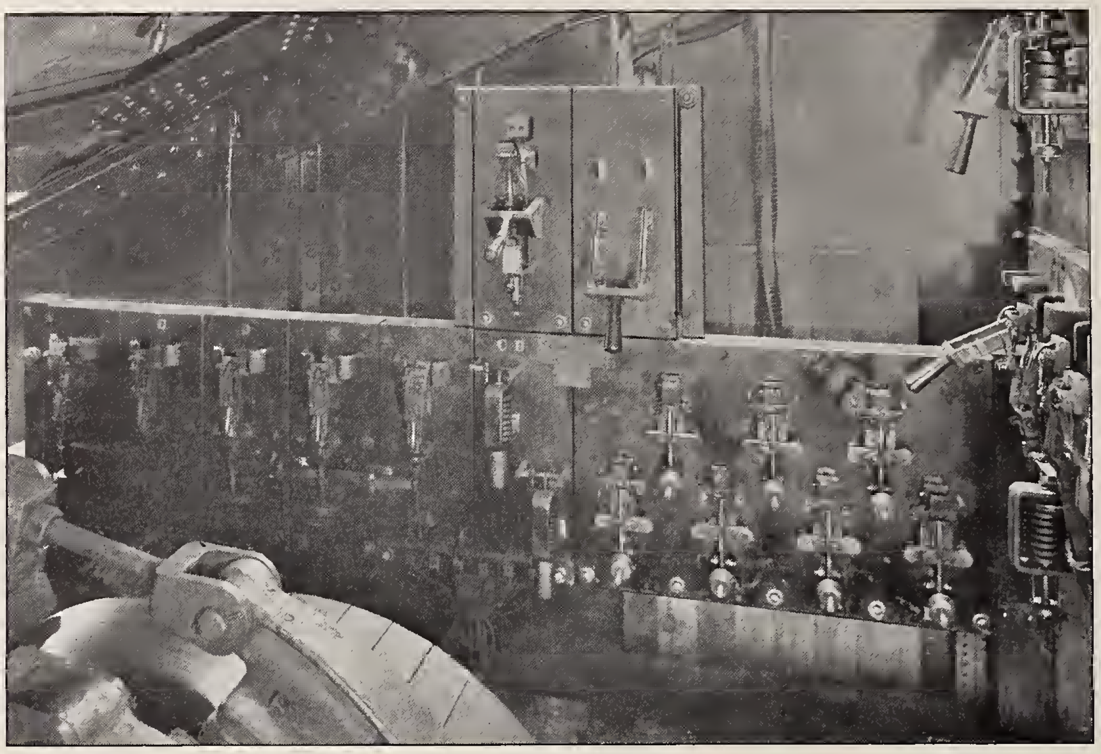


FIG. 3.—THE MAGNETIC SWITCH CONTROLLER FOR THE OPERATION OF THE GRAB OR CLAMSHELL BUCKET

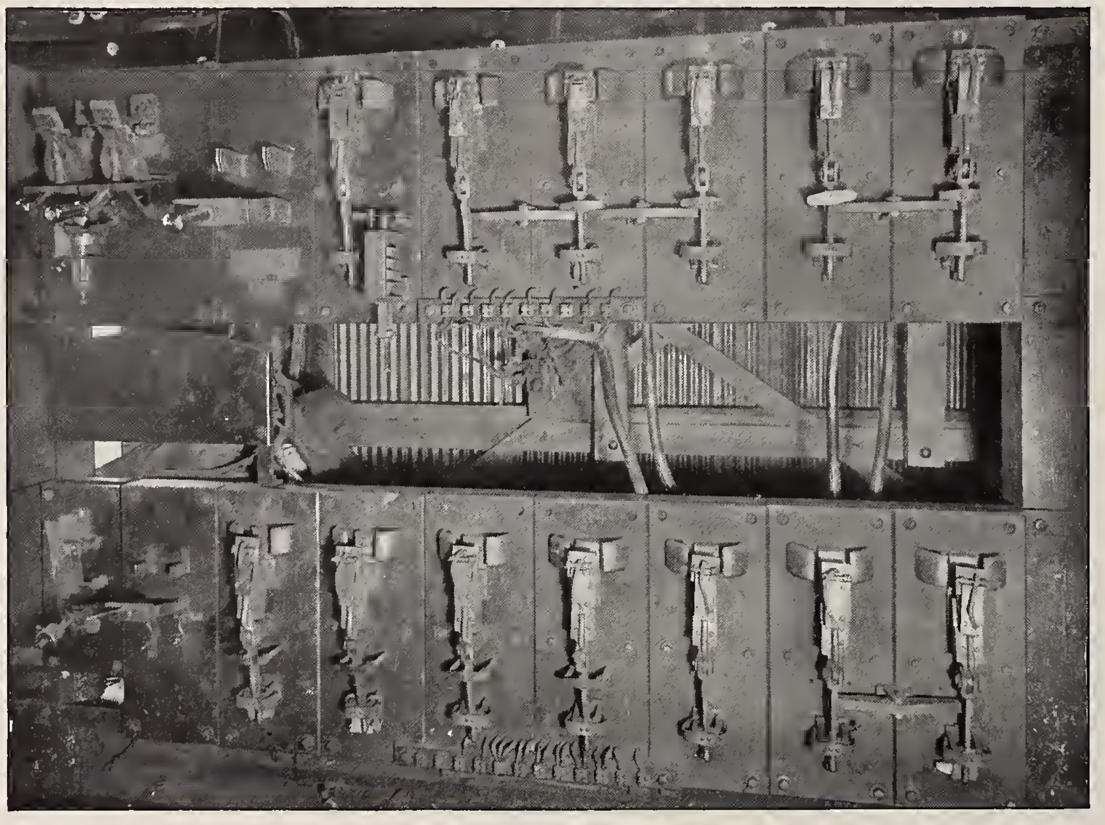


FIG. 5.—THE MAGNETIC SWITCH CONTROLLER FOR THE OPERATION OF THE BUCKET-CAR HAULAGE MOTOR

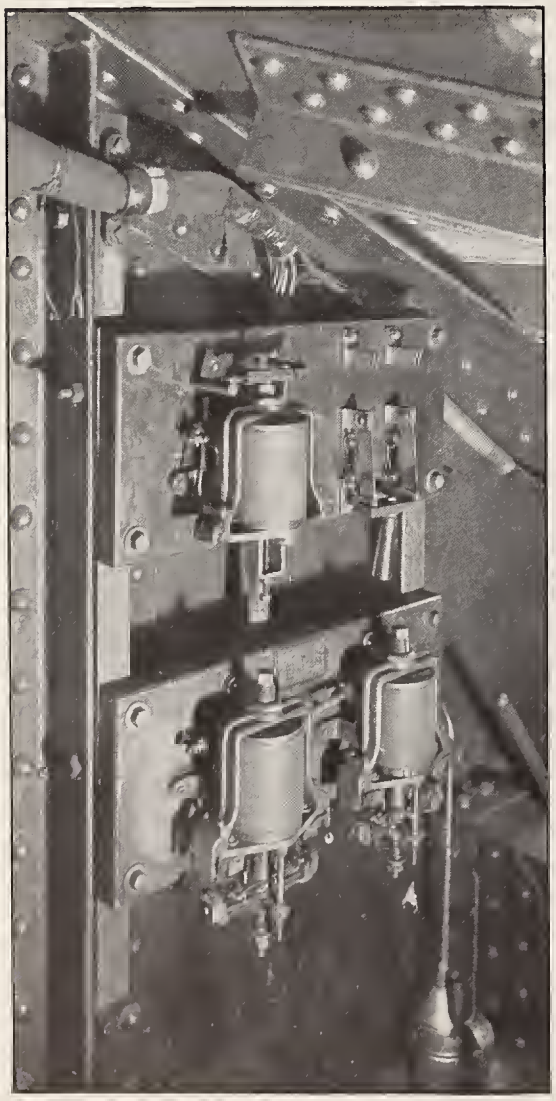


FIG. 4.—THE MASTER CONTROLLER FOR OPERATING THE BUCKET ROTATION MOTOR

FIG. 6.—THE BUCKET-CAR OPERATOR'S CABIN, SHOWING THE MASTER CONTROLLER

the middle or dynamic braking switch when the motor is still connected to the line and operating as a motor. The levers are also used to hold open the switches at either side of the center switch when the motor is acting as a generator with the center switch closed.

Fig 3 shows the magnetic switch controller for the operation of the grab or clamshell bucket. The smaller switches, at the left, are the accelerating or resistance switches. These switches are so connected that the succeeding one depends for its closure upon the closure of the one preceding. One terminal of the operating solenoid of each switch is connected to such a point on the resistance that the current, taken by the motor upon the closing of the preceding switch, must fall to a certain predetermined value before the following switch can close. This means that the motor must come up to a speed corresponding to each accelerating switch before the following switch will close. This is claimed to give a uniform acceleration in the shortest time consistent with safety to motor and driving mechanism, to make acceleration of the motor entirely independent of the operator should he throw the master switch with extreme rapidity, and to keep a predetermined pressure on the bucket jaws that will not be exceeded. The motor is generally stalled once during every closure of the bucket, and this is said to occur without injury to the motor, controller or attached mechanism.

FIG. 7.—THE AUTOMATIC SLOW-DOWN AND CUT-OUT SWITCH FOR BUCKET-CAR MOTOR

The master controller for operating the bucket rotation motor is shown in Fig. 4. Fig. 5 shows the magnetic switch controller operating the bucket car haulage motor.

The ore is dumped from the bucket into a car, which is pulled up the incline by a motor located in the machinery house underneath the trolley. The car is automatically dumped near the end of its travel by means of mechanical dogs.

Figs. 6 and 7, respectively, show the master controller and automatic slow-down and cut-out switch which control the motion of the car. The manually-operated controller to the left of the master controller is used for the purpose of slewing the entire machine so that it may be brought parallel to the hatches of the boat. The dock being built on a large curve, makes this motion necessary to secure the best operation. The main controller house is located on the trolley underneath the walking beam, and is divided into two parts, one part containing the machinery and controllers, and the other, the resistances.

This type of control was designed, developed and built by the Electric Controller & Supply Company, of Cleveland, Ohio, who also manufactured and supplied all the magnetic solenoids for band brakes and the other electrical details.

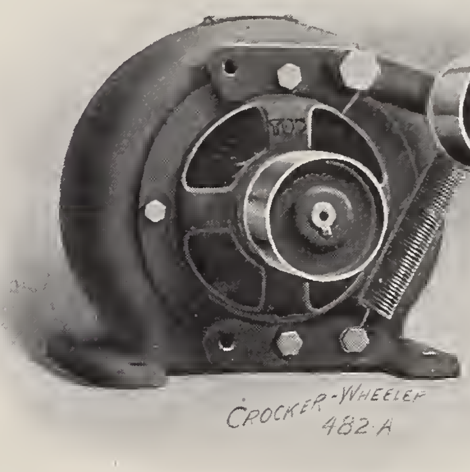
The next meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers will be held at Canton, Ohio, on November 17 and 18.

A New Belt-Tightening Idler

A NEW belt-tightening attachment made by the Crocker-Wheeler Company, of Ampere, N. J., for their form of motor, is shown in the annexed little cut. The device may be used, however, in any case where the limited center distances between pulleys require an increased belt contact on the pulley surfaces.

The principal parts of the belt-tightening attachment are the idler pulley, arm and block, spring-stud and block, and the adjustable spring and hook for connecting them.

The idler pulley and arm are pivoted on a stud which may be screwed into either one of two tapped holes



A NEW BELT-TIGHTENING IDLER MADE BY THE CROCKER-WHEELER COMPANY, AMPERE, N. J., ATTACHED TO ONE OF THEIR MOTORS

in the block. The block itself may be attached to the motor in any one of four positions by a special screw replacing any one of four machine screws holding the rear shield to the motor frame. Eight locations are thus afforded for the pivot of the idler arm.

In selecting which one of these positions to use for any given case, it must be remembered that the idler pulley must rest on the slack side of the belt. The stud to which the spring is anchored may be screwed into either one of two holes in a block similar to the one previously mentioned, and this block may be mounted in any one of the three remaining positions around the rear shield. The position which should be used will depend upon the way the idler pulley rests on the belt.

When the parts are put in position, further adjustment may be obtained by screwing the hook in and out of the spring before hooking them on to the attachment. Adjustment for stretch of belt may also be made in this manner at any time. Care should be taken not to adjust

the spring too tightly. The idler pulley resting very lightly on the slack side of the belt will give a powerful drive on the tight side. If the slack side is strained too tightly, the tight side may be strained so much as to break the belt when the load comes on.

Personal

W. T. McCaskey, who was, until recently, manager for Agar, Cross & Co., of London, and for years before identified with Edison, Westinghouse and other electrical interests, has joined the Allis-Chalmers Company. He will act as a special representative where contracts are being considered for such work as the equipping of interurban railroads, hydro-electric projects and others requiring special knowledge. Mr. McCaskey is a native of Wisconsin, having been born in Richmond County in 1863. His experience in electrical work began in 1882, when he took charge of the plant of the Eau Claire Electric Light & Power Company. Later he was connected with Sperry Associate Electric Company, of Kansas City, and he operated the first electric lighting plant in Fort Worth, Tex., in 1885. From 1889 to 1894 he was on the Pacific Coast and connected with Edison and other interests. He spent the years from 1894 to 1899 in Chicago as a representative of the Standard Electric Company and general contractor, and then went to Buenos Ayres, South America, to represent the Westinghouse Electric Manufacturing Company and Agar, Cross & Co., where he remained until 1901. He was director in Spain and Portugal for the Societe Anonyme Westinghouse until December, 1903, and manager for Agar, Cross & Co. until May 1 of this year. Mr. McCaskey will make his headquarters in Milwaukee.

Kenneth B. Thornton has been appointed operating engineer of the Canadian White Company, of Montreal. Mr. Thornton is a past president of the Canadian Electrical Association and is an associate member of the American Institute of Electrical Engineers and the Canadian Society of Civil Engineers. After taking a three years' course in electrical and mechanical engineering at the Central Technical College at South Kensington, London, England, Mr. Thornton returned to Montreal and entered the employ of the Royal Electric Company, in the manufacturing, testing, and drafting departments. In 1895 the Royal Electric Company was supplying light and power in and around Montreal. At that time Mr. Thornton was transferred to the operating department, and from that time until August, 1905, he was intimately associated with the construction, operation, and engineering details in connection with the generation and distribution of light and power for the Royal Electric Company and the Montreal Light, Heat & Power Company. This latter company secured a monopoly of the electric companies in Montreal in 1903. The amount of power generated increased from 7000 H. P. in 1895 to over 30,000 H. P. in 1905.

The election of Walter H. Whiteside as president of the Allis-Chalmers Company is an indication that the change in the presidency will not mean a change in the policy of the company, for Mr. Whiteside has been, during the absence in Europe since April last of his predecessor in office, in full charge of the operations of the organization with the title of vice-president and general manager. Mr. Whiteside joined the Allis-Chalmers interests in July, 1904, when he accepted the position of general manager of sales. He came at a time when the company, which had just taken over the Bullock Electric Manufacturing Company, needed the injection of a vigorous and energetic personality into its sales force. The task with which Mr. Whiteside was confronted was one which would have baffled any man with less determination, less energy, and less force of character. It was not merely that he had to become familiar with all the intricacies of the company's varied products, but the new interests and the old had to be consolidated. The sales organization had to be enlarged and its efficiency increased. With what success Mr. Whiteside has met in his efforts, the increase in the volume of the company's business, and the crowded shops, and the reopening of the old South Foundry at Milwaukee can testify. In taking up this higher and more responsible position, Mr. Whiteside has behind him not only the confidence of his organization, but a long and varied business experience, in which he has filled many executive positions. His achievements have won him recognition as a man of marked administrative ability. He enters upon his new office amid the congratulations of a very wide circle of business

WALTER H. WHITESIDE, THE NEW PRESIDENT OF THE ALLIS-CHALMERS COMPANY

friends and associates. Mr. Whiteside is a member of the American Institute of Electrical Engineers, of the Engineers' and Lawyers' Clubs of New York, of the Mid-Day Club, Chicago, and of the Milwaukee Club.

At the annual meeting last month at Philadelphia, of the American Street Railway Association, W. Caryl Ely, president of the International Railway Company, of Buffalo, was elected to the presidency of the association for the third time.

W. CARYL ELY

Charles Garland has recently resigned the position of secretary of the Westinghouse Machine Company to become prominently identified with the Pittsburg Fireproofing Company in the official capacity of vice-president and treasurer. Mr. Garland enjoys the distinction of having remained in the continuous service of one establishment for over twenty-one years. Arriving in Pittsburg from his native Ireland in 1883, at the age of 14, he entered the employ of the Westinghouse Machine Company, which at that time had been in existence but three years. From a minor position, Mr. Garland's advancement more than kept pace with the rapid growth of the company, until in 1896 he was appointed assistant secretary and assistant treasurer. Two years ago he was advanced to the full secretaryship, which he held up to the time of his resignation. The Pittsburg Fireproofing Company, with which Mr. Garland has become identified, is a growing concern, engaged in the manufacture of fireproof material of many kinds. Its works are located at West Pittsburg, Lawrence County, Pa., and its main offices in the Bailey-Farrell Building, Pittsburg, where Mr. Garland has his headquarters.

Robert McF. Doble, consulting engineer of the Abner Doble Company, San Francisco, has returned from a trip of several months through the Sierra Madre Mountains on the west coast of Mexico, and also in Colorado, where he was engaged in making examinations of several important hydro-electric long-distance power projects.

A. T. Tomlinson has been transferred from the New York office of J. G. White & Co. to the Montreal offices of the Canadian White Company. Mr. Tomlinson is a graduate of the Royal Military College of Canada, and has had a wide experience in railway engineering. Immediately previous to his connection with Messrs. J. G. White & Co., in 1902, he was consulting engineer for the Boston Elevated Railway. He had charge of a large part of the construction and resigned before the completion of the work.

W. E. Schoenborn announces that he has entered upon the practice of patent law, and places his training as graduate of engineering and law, experience of fifteen years on the examining corps of the U. S. Patent Office, together with his knowledge of the patent laws, systems and practice of the United States and of the various foreign countries, at the service of inventors and all others having matters concerning patents, designs, trade-marks, labels and copyrights. While in the Patent Office Mr. Schoenborn made special efforts to be detailed in the most active divisions of said office, thus having direct charge in the examination of many important classes of invention relating to electrical, mechanical, chemical and metallurgical arts; also becoming well acquainted with the personnel of that office and familiar with the practice and intricacies concerning the preparation and prosecution of applications for patents and procedure in interference cases.

George Hill, consulting engineer for buildings and plants, announces the removal of his office to 33 Union Square, West, New York City.

J. G. White & Co., of New York, have secured the services of J. F. Witmer, B. A., C. E., of Buffalo, N. Y., who will assume charge of special work for them in connection with hydraulic engineering in foreign fields. Mr. Witmer is a specialist of many years' standing, with offices at Buffalo, N. Y., and during the last ten years has designed and superintended the construction of water works systems at upwards of thirty different towns and cities in the United States.

M. C. Miller, who joined the Allis-Chalmers Company a little more than a year ago, has been made assistant to the sales manager. He takes charge of all matters in that department which do not require the personal attention of the sales manager. Mr. Miller was formerly connected with the Westinghouse Electric Manufacturing Company at Pittsburg.

O. A. Stranahan, who joined the Allis-Chalmers Company on December 1, 1904, to become manager of the power department, has been promoted to the position of sales manager. Mr. Stranahan assumed the duties of his new place on September 1. His headquarters are at Milwaukee.

James C. Hain recently resigned as engineer of masonry construction for the Chicago, Milwaukee & St. Paul Railroad, and is now associated with J. G. White & Company as superintendent of masonry construction with headquarters at 45 Exchange Place, New York. Mr. Hain graduated in 1893 from the University of Wisconsin with the degree of B. S. in C. E. The university conferred upon him the degree of C. E. in June, 1905. He was with the Chicago, Milwaukee & St. Paul Railroad for ten years, and in that time gained a broad experience in the work which is supervised by its bridge and building department. While with this company he also had experience in general design and in detail computation and drawing. He also performed outside duties of surveying, collecting data, and other work relative to replacing wooden bridges and other temporary structures with permanent masonry construction. During the year 1900-01 he was in charge of the construction of the large ore dock and approaches at Escanaba, Mich. In 1901 Mr. Hain was appointed engineer of masonry construction, and in that capacity supervised all work of this nature that has been done during the last four years by the Chicago, Milwaukee & St. Paul Railroad on their 7000-mile system.

Vernon H. Rood, vice-president and general manager of the Jeanesville Iron Works, Hazleton, Pa., died suddenly on September 2, at Bad Naudheim, Germany, where he had recently gone for the benefit of his health. Mr. Rood was 48 years old. He was born in Elyria, Ohio, November 10, 1856, and was a son of

the late Homer B. Rood. He was a graduate of Stevens Institute of Technology, and a member of the American Society of Mechanical Engineers. For the past fifteen years Mr. Rood had devoted his entire time and energy to the perfection of mine pumps, and during that time he achieved a great deal of success. Much as his sudden loss will mean to his profession it will be a greater and more poignant affliction to his hosts of friends. Mr. Rood's was a strong, just and kindly personality. Those who were his friends will mourn deeply for the hearty hand clasp and the loyal sympathy with which he was always ready.

With the autumnal homeward tide from abroad there have returned within the past month, among others, George Westinghouse, Frank J. Sprague, Arthur Williams, Oskar T. Crosby, and J. J. Carty, chief engineer of the New York Telephone Company.

Mr. Williams, as already noted in these columns, went abroad primarily for rest and recreation, but devoted some time also to the study of the municipal ownership situation in the electrical field in the interests of his company,—the New York Edison Company.

Mr. Crosby has of late years been interested in things a bit outside of the electrical field, and at present is busy in finishing up his book on "Thibet and Turkestan," which is based upon his personal observations in those countries.

F. E. Valentine, the newly elected president of the Ohio Electric Light Association, is also secretary and manager of the Miami Light, Heat & Power Company, of Piqua, Ohio.

The Allis-Chalmers Company has recently appointed as manager of its newly created foreign department, Eugene Holcomb, who takes charge of all the foreign agencies and foreign selling representatives of the company. Not only will he supervise the work of the well-established European and South African offices, and all Eastern Hemisphere agencies, but he will also have direct control over the South and Central American business for the company. With the engineering possibilities and projects in South America, Mr. Holcomb is thoroughly familiar, having spent a number of years in that country. The past three years he has had immediate charge of the Westinghouse Companies' interests in Argentina, with headquarters in Buenos-Aires. Under his supervision the great gas power plant of the Southern and Western railroads of Argentina was designed and installed, including a complete gas producer plant, making the gas from bituminous slack. These complete power plants, operated entirely by gas, and installed at an aggregate cost of upwards of a million dollars, supply not only power for operating the machinery in the immense railroad shops, but through underground cables transmit power 10 miles to operate the cranes and ship-loading devices at the docks of the railroad company, marking a step in advance of any gas power plant up to date, an engineering feat of which Mr. Holcomb may be justly proud. Mr. Holcomb received his early training in the steam engine and electrical industry on the Pacific Coast and Middle West, selling his electric light and contracting interests in Illinois to take up foreign work with the Westinghouse Companies. His knowledge and experience in the engineering fields of this country, and the engineering projects he has carried through abroad, make Mr. Holcomb a valuable acquisition to the Allis-Chalmers Company, with which he is now identified. His headquarters will be at the general offices of the company at Milwaukee, Wis.

Obituary

With the recent death of Prof. Franz Reuleaux, in Germany, at the age of seventy-six, the world has lost the greatest machine philosopher of modern times,—one of those scholars whose investigations have added immensely to the stock of common international engineering knowledge, and the results of which have taken firm root in all countries. Franz Reuleaux was a universal genius, epoch-making in his profession, a creator and a leader in the most important domains of human science and knowledge, interested in everything that is noble and great, appreciating all that is eminent among foreign people, a cosmopolitan in the noblest sense of the word.

William Birch Rankine, Niagara Falls' most prominent citizen and a man honoured and beloved by all who knew him, died at Franconia Inn, in the White Mountains, of New Hampshire, on September 30. Mr. Rankine was born in Owego, New York, on January 4, 1858. He was educated at Hobart and Union Colleges, graduating from Union in the class of 1877 with the degree of A. B., and later receiving the degree of A. M. from both colleges. His father, the Rev. James Rankine, D. D., LL. D., of Geneva, N. Y., was prominent, during his life, in educational work, having been a professor at Trinity College, a trustee of Union and Hobart College, president of Hobart College, and the rector of the Delancey Divinity School, of Geneva, N. Y. Mr. Rankine studied law in the office of the late A. Augustus Porter, and was admitted to the bar in 1880. He was engaged in the general practice of law in New York City until 1890, since which time he devoted his time particularly to the development of Niagara power and other interests on the Niagara frontier. In 1899, he changed his residence to the city of Niagara Falls. He was the second vice-president and treasurer of the Niagara Falls Power Company, Niagara Junction Railway Company, and Niagara Development Company, vice-president of the Canadian Niagara Power Company, president of the Clifton Hotel Company, Ltd., of Niagara Falls, Ont., and a director, stockholder and officer in a large number of corporate institutions and clubs. He was married on February 23, last, to Miss Annette Kittridge Norton, daughter of Mrs. E. K. Norton. Besides his wife he is survived by his mother in Geneva, and three brothers, Richard, deLancy and Harold.

New Catalogues

A number of new publications have been issued by the General Electric Company, of Schenectady, N. Y., chief among which may be mentioned those treating on electricity versus steam for train haulage, enclosed fuse cut-outs and fuses, key and keyless sockets, concentric diffusers for incandescent lamps, Edison lamps, switchboards for continuous-current railway systems operated from three-phase generators, synchronism indicators, and induction test meters.

The National Electric Company, of Milwaukee, illustrate and describe in two bulletins, their direct-current belt-driven generators, and the Christensen air-brake system manufactured by them for urban and interurban electric cars.

A bulletin of information regarding the ratings and dimensions of generators and motors as built by the Northern Electrical Manufacturing Company, of Madison, Wis., has been sent out by that company; also a leaflet treating of their electric forge blower equipments.

The De Laval Steam Turbine Com-

pany, of Trenton, N. J., supply information and illustrations of their steam turbine machinery in an attractive booklet.

Among the new publications brought out by the Fort Wayne Electric Works, of Fort Wayne, Ind., are those illustrating and describing their induction motors, transformers, and their series alternating-current arc lighting system.

"Westinghouse Railway Apparatus" is the title of a publication recently issued by the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., for distribution at the recent convention at Philadelphia of the American Street Railway Association. This book illustrates and describes in a general way alternating and direct-current railway motors as built by the Westinghouse Electric & Manufacturing Company, as well as their generators for railway work and systems of control for electric railways. It also illustrates and describes their system of catenary line construction for street railway work. Information covering the detail and repair parts of motors and other railway apparatus is embodied in the work. In two additional publications recently issued, their prepayment wattmeters and a new type of railway motor are illustrated and described.

A catalogue recently issued by The C. & G. Cooper Company, of Mount Vernon, Ohio, contains a number of illustrations of the Corliss engines built by this company for electric lighting, railway, rolling mill, textile, and general manufacturing work.

The Moore Electrical Company, of Newark, N. J., give particulars of the Moore electric tube light in a new booklet.

Hornsby-Akroyd oil engines, built by the De La Vergne Machine Company, of New York, are well presented, together with illustrations and descriptions of the various installations in which they are used, in a 74-page catalogue.

The Wagner Electric Manufacturing Company, of St. Louis, Mo., are sending out three new publications. In one of these the recent developments in single-phase alternating-current motors are discussed, in another, their combined voltmeter and frequency indicators, and in the third the operation and construction of their lighting and motor transformers.

Trade News

That the mechanical stoker has reached such a state of perfection as to be considered indispensable in the equipment of modern boiler plants, is indicated by the large number of orders booked by the Westinghouse Machine Company for the Roney stoker,—a type of their exclusive manufacture. During the past month orders have been received for no less than 51 Roney stokers, ranging in size from 54 x 20-inch grate to 132 x 26-inch grate, the largest of the orders being that of the Pennsylvania Railroad for six 132 x 26-inch grate stokers and five 100 x 20-inch grate stokers. A large order from the Ohio Hospital for Epileptics, at Gallipolis, Ohio, has also been received, and others from the American Bridge Company, Ambridge, Pa.; National Tube Company, Pittsburg, Pa.; Detroit United Railway Company, Detroit, Mich.; York Engineering Company, York, Pa.; Proctor & Gamble Company, Cincinnati, Ohio; the Union Rolling Mill Company, Cleveland, Ohio; Gulfport & Mississippi Coast Traction Company, Gulfport, Miss.; United Presbyterian Board of Publication, Pittsburg, Pa.; Indiana Boys' School, Plainfield, Ind.; Baltimore & Ohio office building at New York City, and the Railway Exchange Building, at Chicago, Ill.

The Animas Canal, Reservoir, Water Power & Investment Company, of Colorado, has just ordered from the General Electric Company, of Schenectady, N. Y., six 60-cycle, 750-KW. water-cooled transformers having double primary voltage,—47,500 and 38,000,—with four secondary voltages,—15,300, 16,150, 17,000, and 17,850. The switchboards of this sub-station consist of two three-phase incoming line, step-down transformer panels, capacity 2250 KW., 50,000 to 17,000 volts. Lightning arresters are also included in the order. This apparatus will be installed at the sub-station at Silverton, Col., where distribution of power to the surrounding mines will be made.

The De La Vergne Machine Company, of New York City, builders of gas and oil engines besides refrigerating and other machinery, are sending out neat and useful reminders of themselves in the shape of a 5 by 7-inch card giving the properties of saturated steam.

The Columbia Battery Company is the name of a new company, with headquarters at Milwaukee, Wis., formed for the manufacture of electric storage batteries for vehicles and launches, stationary lighting plants, electric bells, etc.

The New York Telephone Company are rapidly perfecting the details for their exhibit at the Madison Square Electrical Show, to be held at New York City next month. The space chosen by them is a circle directly in the middle of the Garden. This circle is about 30 feet in diameter, and over it will be hung an enormous blue bell, covered with incandescent lights. This bell will be of the same bottom diameter as is their space and will extend up almost to the roof of the Garden. In the booth itself there will be, among other interesting exhibits, a telephone central station. This central station will, like almost all the other exhibits in the Garden, be in use. Every exhibitor will have his telephone in this booth connected to this exchange, and during the show all the Garden business will be carried on through it. The same idea of making practical exhibits is being carried out very largely in the plans of those who have already signed contracts, and instead of being an unusual matter to find a working exhibit, as is the case in most shows, it will in the case of the Garden show be an unusual matter to find one that is not a working exhibit.

The Bruce-Meriam-Abbott Company, of Cleveland, Ohio, recently secured orders for a 100-H. P. gas engine to be installed by the E. R. Thomas Motor Company, of Buffalo; also for two 35-H. P. engines direct connected to two 20-KW. generators to be used for a lighting plant by the T. & E. Dickinson Company, jewelers, of the same city. Two 27-H. P. units have been shipped to Chicago, to be used for lighting purposes. The company have also sold recently for lighting purposes in Cleveland and vicinity four 50-H. P. engines and a number of smaller engines. They are building engines from 8 up to 125 H. P. of the vertical twin-cylinder type, especially adapted for electric lighting service.

The Alberger Condenser Company, 95 Liberty street, New York, and 205 La Salle street, Chicago, announce that they have recently acquired the entire Wainwright business, and will hereafter manufacture and sell the well-known Wainwright feed-water heaters and expansion joints. These specialties have lately been manufactured by the Taunton Locomotive Manufacturing Company, Taunton, Mass., who are now going out of business. William R.

Billings, formerly treasurer and general manager of that company, has become connected with the Alberger Condenser Company, and will be in charge of the Wainwright business under its new ownership.

The rapidly increasing business of the Morse Chain Company has necessitated the building of a large new plant at Ithaca, N. Y., which will be operated in conjunction with the present factory of the company situated at Trumansburg, N. Y. It is the intention of the Morse Chain Company to make this new plant a model one in every way, and ample facilities for future expansion will be provided. The machine shop will be equipped with 10-ton electric traveling cranes, as the light nature of the material under construction does not warrant the installation of very heavy cranes. The foundry will be equipped with electric cranes of 15 tons capacity having a span of 50 feet.

With the recent completion of a large extension equipped with the most modern electrical and mechanical appliances and machinery, the International Acheson Graphite Company, of Niagara Falls, N. Y., has doubled the capacity of its plant for making graphite in the electric furnace. The company has closed a contract with the Niagara Falls Power Company for another 1000 horsepower of electrical energy in addition to the 1000 horse-power previously used. The commercial importance of this artificial graphite may be estimated from the fact that the United States Geological Report for 1904 states that for that year the value of Acheson graphite produced was $217,790, while all the graphite mined in this country amounted merely to $341,372. New York State, which is considered rich in deposits, according to the official report of 1904 produced natural graphite worth $119,509. Acheson graphite is largely used in the manufacture of metal protective paints, dry batteries, stove polish, packing, and as a lubricant. The electrochemical processes also consume an extensive supply of Acheson graphite electrodes.

A Single-Jet 8000-H. P. Water-Wheel

THE Abner Doble Company, of San Francisco, has recently received several interesting orders for Doble tangential water-wheels. Prominent among them is an order from the California Gas & Electric Corporation for a 9000-H. P. wheel for its De Sabla power plant. This wheel will be similar to the 8000-H. P. Doble wheel installed in the De Sabla plant last year, and the three 8000-H. P. Doble wheels recently completed and now successfully operating in the new Electra station of the same company. The wheel will operate under a head of 1530 feet at 400 revolutions per minute and will be driven by a single jet of water, thus making it the most powerful water-wheel ever constructed for operation under a single jet of water. Another order from the California Gas & Electric Corporation calls for six 570-H. P. wheels for its Nevada City plant. These will operate under a 190-foot head at 410 revolutions per minute.

A 400-H. P. Doble wheel for operation under a 400-foot head, equipped with jet deflector operated by a Woodward compensating governor, has been shipped to the Chancellor Gold Mining Company, Wenatchee, Wash. The La Grande Water Storage Company, La Grande, Ore., has purchased an 800-H. P., 1150-foot head, 600 revolutions per minute Doble wheel, equipped with Doble needle regulating nozzle for operation by a Lombard governor. Among other recent orders secured by the Abner Doble Company are two double 1750-H. P. wheels for the San Joaquin Power Company, Fresno, Cal., for operation under 385-foot head; one Doble needle regulating nozzle for a large water-wheel for the Komata Reefs Gold Mining Company, New Zealand, and a double 700-H. P. water wheel unit for Mitsui & Company, Japan, for operation under 210-foot head, this order including the wheel complete with Lombard governor and gate valve.

The University of Michigan has purchased the Doble tangential water-wheel which the Abner Doble Company exhibited at the St. Louis World's Fair, and for which the company was awarded the grand prize. This wheel is to be installed in the hydraulic laboratory of the new Engineering Building at Ann Arbor, Mich., where it will be mounted in connection with a duplex pump for experimental purposes, its output being 100 H. P. when operating under a head of 580 feet.

The 12-inch laboratory water motors which the Abner Doble Company builds for technical schools and universities have attracted considerable attention among the engineering faculties of many of the leading educational institutions, and the interest shown in these small water-wheels has resulted in an increasing demand for them, orders having recently been received from the University of Wisconsin, the Michigan School of Mines and the University of Toronto.

The Allis-Chalmers Club

THE Allis-Chalmers Club, recently opened at Milwaukee, is located at the southeast corner of Hanover and South Pierce streets, within a few blocks of the Clinton street plant. W. H. Whiteside, vice-president and general manager of the company, has been very active in establishing the club on a good basis. It has been organized for the purpose of facilitating social intercourse among the officers and employees of the company, the membership being open to employees in the office and drawing room. A noonday luncheon will be served, a separate room being reserved for women.

A membership fee of $1 is charged and the receipts from the fees are to be applied toward the purchase and maintenance of a library for the use of club members. A board of management has been appointed from heads of departments and the engineering and office departments and consists of David Harlowe, W. E. Dodds, Almon Emery, W. S. Heger, T. J. Illing, J. A. Milne, Carl Printz and H. Shifflan The building secured for the clubhouse was formerly used as a residence, but is well adapted to the present purpose. It is large, affording ample room, and is surrounded by beautiful grounds. A uniform price of 35 cents for men and 25 cents for women will be charged for the noonday luncheon.

Concentration of power is in harmony with the centralizing tendencies of the times, and in the consolidations of the future, uniform equipment in electric central stations is going to play an important part in the reduction of expenses. There is little danger of going too far in this direction in new plants, but in many of the older installations it is high time to look about and see what can be done towards eliminating superfluous apparatus, or that equipment which has become obsolete through the development of better types.

The world's production of aluminium in 1903, the latest year for which figures are available, was 8252 metric tons of 2204 pounds, distributed as follows: United States, 3400 tons; Switzerland, 2500 tons; France, 1700 tons; United Kingdom, 650 tons.

Evolution in Chemistry and in the Universe

IN the opinion of the vigorous physicist, says "Engineering," of London, the term "evolution" should be restricted to the domain of biology. That is a field in which the simple laws of physics cannot be applied. We can calculate the energy contained in a pound of sodium or of coal; the energy in living protoplasma is still a mystery to us.

We now retain the distinction between organic and inorganic chemistry merely for convenience sake. The list of so-called "organic" compounds synthetically prepared from inorganic substances is being increased every day. For all that, we are apparently as far removed as ever from artificially producing anything living. The popular cry, "Electricity is life," or "Magnetism is life," does not advance us at all.

Some time ago attention was drawn to the researches of a Russian chemist who, merely by electrolysing water containing carbon dioxide and certain salts, claimed to have prepared sugars and similar products. The work appeared to be carefully conducted. Even if confirmed, it would not have helped us, however, over the fundamental bar between the living and the non-living in the strict sense; and it has not been confirmed. We seem to have in the inorganic world to deal with matter which can always be brought back to the original state, but which is never capable of multiplying; while the organic being—the individual—does multiply as such, and cannot be reduced to its original condition. The fact that the barrier between the two domains is very indistinct does not dispose of the fundamental difficulty.

To speak of evolution in physical chemistry may under these circumstances appear to be unjustifiable. But when the president of the British Association, Professor George H. Darwin, a renowned mathematician and physicist, chooses evolution as the subject of his address, we may anticipate that the son of the great originator of the conception of evolution and natural selection will widen our horizon and enable us to look at these difficult problems in a new light.

He stated that the man who propounds a theory of evolution is attempting to reconstruct the history of the past by means of the circumstantial evidence afforded by the present. The historian has the advantage over the evolutionist in that he has the written records of the past on which to rely. The tasks of the two are different, but equally difficult. The facts on which theories of evolution are based may be likened to a confused heap of beads; the historian, we think, has as much trouble to establish and to string together his facts. That inanimate bodies have also a history is only beginning to be understood. If we take history in its wider sense, we are led to the conception of evolution, though we should probably not pair it with the idea of natural selection with which Professor Darwin combines it.

Inspired by the fascinating idea that matter of all kinds has a common substratum, the alchemists of the Middle Ages conceived the possibility of transforming the baser metals into gold. The discovery of an appropriate series of chemical operations seemed to be the only obstacle to be overcome. The alchemists hoped to be able to break up the atoms of a chemical element into its component parts, and reunite them afterwards into atoms of gold. The atomistic theory seemed to negative such speculations. In the light of the researches of the last ten years, however, the possibility of a spontaneous dissociation and transmutation of elements does not altogether appear to be out of question.

Ten years ago the essential diversity of chemical elements was still accepted as a fact. The elements were supposed to consist of atoms, parts which could not further be separated, and the chemist thus proceeded much in the same way as the biologist, who, in discussing evolution, accepts the species as his working unit. But the study of radiations in their different aspects has forced the opinion upon us that the atom is not indivisible, and that the atomic bricks are themselves built up of component parts.

In the simplest of the known atoms, the hydrogen atom, we presume about eight hundred parts; the atoms of the denser elements may consist of thousands of ultimate parts. These parts have been termed "corpuscles" or "electrons," and they may be described as particles of negative electricity, which repel one another. Various experimenters agree that some of these particles move about with speeds approximating in some cases to the speed of light. What prevents their breaking asunder is quite hypothetical. J. J. Thomson imagines the atom to represent a globe charged with positive electricity, inside which there are hundreds or thousands of corpuscles of negative electricity, revolving in regular orbits with great velocity. The forces called into play by the electrical interaction would be very complicated. So far J. J. Thomson has limited his detailed examination of the model atom to one containing about seventy corpuscles. If the movements of the corpuscles are to be persistent or stable, the corpuscles must revolve in definite orbits, and we thus arrive at an analogy between a complex modern atom and a planetary system.

The stability of the atomic unit, regarded as a system, may last for millions of seconds. Finally, we may expect it to break up, possibly by rejecting or expelling some of the corpuscles. Then another phase of stability will result. Infinite numbers of such communities would be conceivable, representing an infinite number of elements. Professor Darwin did not carry this argument further; mathematical considerations restrict the field. But the eternal indestructibility of the element is gone. We have to regard different elements as more or less successful in the struggle for life, and we cannot believe that the successful species have existed for all time, or that they will continue to do so.

The laws which govern electricity in motion indicate that an atom must lose energy by radiation, and must finally run down as a clock does. In this sense Thomson has spoken of elements which may run for a million years. In radium and in other elements of very complex character, we probably witness this breaking-up process and the spontaneous rearrangement of the atoms which would constitute a transmission of the elements. In drawing his own summary, the reader will probably arrive at the conclusion that evolution in physics and astronomy remains highly hypothetical, and that we are only beginning to feel our way to approach these problems. Nobody has attempted to go beyond the nebular phase, except, perhaps, Professors Nichols and Hull. Their experiments on the mechanical pressure of light would seem to render it preferable to start with more or less coarse inital particles than with a gaseous nebula. Considering that man is but a microscopic being relatively to universal space, and that he lives on a puny planet circling round a star not of the first rank, it may appear futile to imagine that he will ever discover the origin and the tendency of the universe. Yet man will pursue his search as long as he shall last. To that concluding remark of Professor Darwin's, everybody will assent. The progress made during the last decade may be bewildering; but it justifies hope of yet greater progress in the future,

Electric Traction in Continental Europe

By FRANZ KOESTER

Concluded from the September Number

FIG. 28.—ONE OF THE THREE 120-H. P. ELECTRIC LOCOMOTIVES BUILT FOR THE JUNGFRAU RAILROAD BY THE OERLIKON MACHINE WORKS, ZURICH, SWITZERLAND

IN no other European country is electric traction so universally employed as in Switzerland. Like Italy, not having many coal mines to supply steam railroads, Switzerland was forced to utilize water power, with which it is richly blessed, and as no other form of power could be so easily developed from water as electricity, we have in this the direct cause of the number of electric roads in Switzerland, both for passenger and freight service.

One of the greatest advantages of electric traction for the Swiss mountain roads, immediately noticeable to the traveler, is the absence of smoke and cinders. These in some cases are so annoying as to prohibit the opening of the windows in closed cars, especially on account of the numerous tunnels and valleys. With electricity, open cars may be used, thus adding materially to the enjoyment of the trip.

Of the many mountain railways in Europe, probably the most famous is that on Mount Jungfrau in the Berner Alps, built by the Oerlikon Works, of Switzerland. Part of this road is still under construction. The desire of travelers to climb the majestic Jungfrau and enjoy the wonders of Switzerland, led, in 1889, to a project for an inclined railway, which should start from Lauterbrunnen, 2610 feet above sea level, and reach the peak, 13,665 feet above sea level.

Three other projects were brought forward up to 1890, one of which was a pneumatic-tube railway designed by Mr. Locher, the builder of the Pilatus mountain road. With this system the road was to consist of two masonry tunnels, 9.8 feet in diameter and 3.7 miles in length, having a grade of 70 per cent. The cars, propelled by compressed air, were to consume only 15 minutes in running over the whole course, while in the other cases it required from an hour and a half to two hours. But the tube system would prevent a view being had of the surrounding country,—one of the main reasons for making the trip.

The project which to-day is still under construction was introduced in 1894. The road is electrically operated, and the current is supplied from a hydro-electric plant utilizing the power of the Lütschine, in Lauterbrunnen. On account of the long distance over which the power was to be transmitted, three-phase alternating current was adopted for the feeders as well as for the trolley wires.

Starting in the Lauterbrunnen Valley, the traveler passes the Kleine Scheidegg and Eigergletscher stations, then enters the tunnel and passes the stations Rothstock, Eigerwand, Eismeer, Jungfraujoch, and the terminal Jungfrau from which there will be an elevator to the peak, about 327 feet higher, reaching a point 13,665 feet above sea level as already stated. At each of these stations, which are cut out of the rock in the mountain side, the traveler may leave the tunnel and view the surrounding scenery. The maximum grade, which is nearly the average grade, is 25 per cent. The tunnel between the first two stations is lined, while the latter part, about 6 miles long, is built in solid rock and did not require lining. It is about 12 feet wide and 14 feet high, and has an arched roof.

The three-phase alternating current was transformed and used with a number of direct-current electric drills in building the tunnel. The road is of the rack and pinion type. The rack is placed between the two running rails, which have a gauge of 3.28 feet, and are bolted to iron ties. The rack has a conical head which allows clutches, ordinarily operating as guides, to prevent the cars from jumping the tracks and in emergencies to act as brakes.

A transformer equipment is provided at each of the previously mentioned stations, reducing the potential from 7000 volts to 500 volts, at

FIG. 29.—ON THE LINE OF THE JUNGFRAU RAILROAD. TWO OF THE OERLIKON ELECTRIC LOCOMOTIVES ARE HERE SHOWN

which the current is supplied to the motors through two overhead trolley wires.

There are six locomotives, three built by Brown, Boveri & Co., of Baden, Switzerland, and three by the Oerlikon Works. (See Figs. 28 and 29.) Each locomotive is equipped with two alternating-current motors, designed for 450 to 500 volts pressure, a speed of 750 revolutions per minute, and a frequency of 38 cycles per second, with a normal capacity of 120 H. P. Each locomotive also is provided with two trolley poles equipped with sliding contact shoes. In descending, the motors act as brakes, and as generators may pump back into the line.

There are two kinds of passenger cars,—motor cars and trailers. The former have four axles and are built with four compartments having a total capacity of forty passengers. The trailers are of the two-axle type, also with four compartments of ten seats each. A train is generally made up of one motor car and a trailer. A few freight cars also are in service.

Another interesting mountain line is that running up to the crater of Mt. Vesuvius, in Italy. This starts at the foot of the mountain in the town of Resina, about six miles from Naples. This road was built by Brown, Boveri & Co., and the section electrically equipped is $4\frac{1}{2}$ miles long, leading past the Mt. Vesuvius Observatory to the old cable line 2600 feet above sea level. There the passengers are transferred, carried up the steep side of the lava formations, and landed 3887 feet above sea level, or 328 feet below the crater of the volcano. The steepest grade of the cable road is 63 per cent.

Part of the electric line is a plain adhesion road and part is fitted with a rack and pinion similar to the Jungfrau line. A single overhead wire acts as a feeder, while the rails serve as returns.

On the rack and pinion section a motor car and an electric locomotive are connected together, the train being controlled from the latter. Both are provided with hand brakes and magnetic brakes, the latter consisting of electro-magnets operating in vertical guides. The brake shoes are ordinarily held about one inch above the rails and come in contact with the latter when the coils are energized. Contrary to the usual custom of using iron ties on mountain railroads, wooden ones are here employed. They are easily renewed when damaged, as they frequently may be, by discharged lava. As the cost of maintenance on account of lava flows is considerable, the fare from Naples to the crater and return is $4.20.

The great expense in constructing mountain roads, especially where tunnels are required, as is usual with long roads, is well shown by the following:—

The Gornergrat rack railway in the Southern Alps leads to a point 9305 feet above sea level and is $5\frac{1}{2}$ miles long. It passes over two bridges 78 feet and 272 feet long, respectively, and through five tunnels, the longest of which is 662 feet. This had to be cut through loose mountainous soil and lined throughout its entire length. All the tunnel construction had to be carried on from one end, and all sand and mortar transported on mules.

This road is operated from its own hydro-electric plant, which utilizes the water of the Findelen Lake, fed from the Findelen Glacier. For the Vesuvius road power is supplied by producer gas, the water necessary being rain water collected in reservoirs.

The electric locomotives and motor cars, as well as the entire electric equipment of the traction systems of both the Gornergrat and Vesuvius roads, were installed by Brown, Boveri & Co.

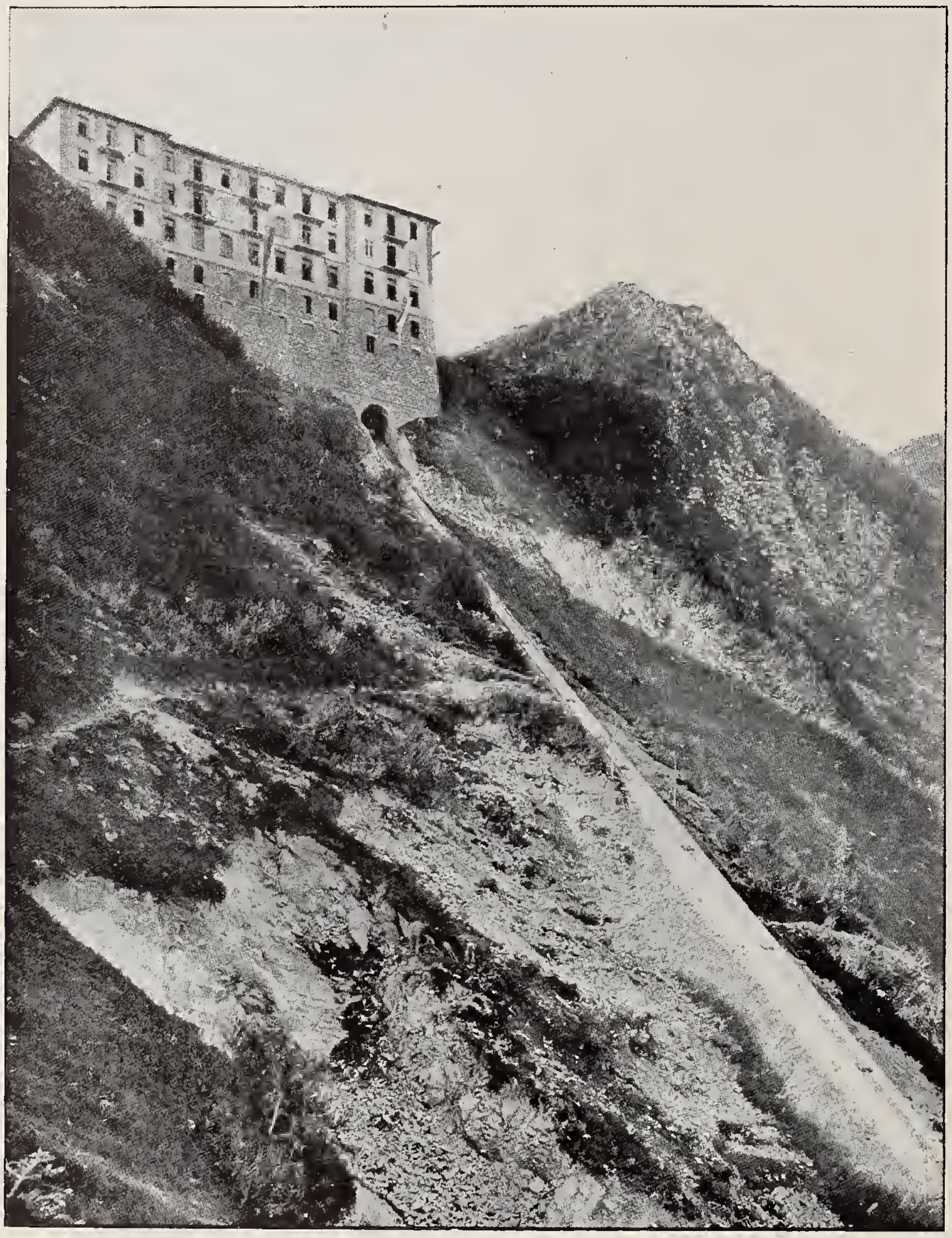


FIG. 30.—ON THE STANSERHORN ELECTRICALLY-OPERATED CABLE RAILWAY IN SWITZERLAND

THE ARCHITECTURAL FEATURES OF ELECTRIC RAILROADS

The Continental engineer having a broad view of the æsthetic side of great municipal undertakings, devotes great care to the artistic development of engineering enterprises. City streets no longer need be made eye-sores on account of having surface lines and elevated roads installed in them. Thus the urban traffic problem may be reduced to the alternatives of an underground road or more pleasing elevated structures, the latter possible only with a closer

FIG. 31.—A SUBURBAN ELECTRIC RAILWAY STATION NEAR BUDAPEST. TYPICALLY ARTISTIC AND IN KEEPING WITH ITS SURROUNDINGS

co-operation of engineers and architests. This is becoming more common in bridge designs.

The Berlin elevated railway is an example of the result of this close co-operation between architects and engineers. It is a work of most artistic finish in both road structure and stations. A glance at Figs. 32 and 33 will help to bear this out.

Take, for example, the station at the Bülowstrasse, Fig. 32, with its ornate iron work, massive stone terminals and well-studied grill work. The heavy stone pillars there shown take the place of the original steel columns which were removed in compliance with a strong public request for something more pleasing to the eye. The station itself is well worthy of remark, furnishing an interesting solution of the combination of stone and iron in a manner appropriate to both. Especially noticeable is the adoption of acroteria at the peak of the gable and at each side, forming a gutter and fully explained by the otherwise uninteresting leader pipes.

An equally successful combination of art and engineering is found in the Nollendorf Platz station, Fig. 33, which marks the dividing line between the elevated and underground sections of the road. The approach is under a rather severe portal of iron and glass, supported by massive stone pillars.

Other stations also along the line are to be commended for the beauty of their artistic treatment, mediaeval in type, to harmonize with the surrounding buildings, and even when there is no special architectural feature, the manner of treatment of the steel columns is a tribute to the engineers and architects.

The elevated road now in course of construction in Paris may be mentioned as another example affording illustrations of the growing artistic tendency. This is true also of the kiosks of the New York Subway, although these cannot be compared with the kiosks of the earlier Budapest underground road shown in Fig. 34.

Some of the characteristic features of the stations of the electric beltline of Vienna are shown in Figs. 35 and 36, that of the Karlsplatz serving as an example of the general class designed for the citizens, while that of Schönbrunn denotes by its more monumental design and elaborate porte cochère that it is intended for the exclusive use of the sovereign and his suite, as is well symbolized by the crown of the Hapsburgs guarding the entrance and exit for the royal equipage.

An illustration of the care which is paid to the architectural features in the suburbs is given in Fig. 31. Here we have a decidedly artistic modern building, thoroughly in keeping with its surroundings.

STORAGE BATTERY AND TRACKLESS TRACTION

In Italy as well as in Switzerland, the cost of coal is excessive, but there are many waterfalls whose power may be transmitted electrically at high tension to the various railway systems. The first steam railroad in Italy was built in 1840, between the cities of Milan and Monza, and the first electrification of a standard railway occurred on the same line in February, 1899, in the form of storage battery motor cars, as shown in Fig. 37. These cars were installed by the Schuckert Company, of Nürnberg.

The storage battery system was chosen in order not to interrupt the existing steam service and was used for passenger traffic only, freight being handled by steam locomotives. These cars are of standard gauge, 58 feet long and divided into first

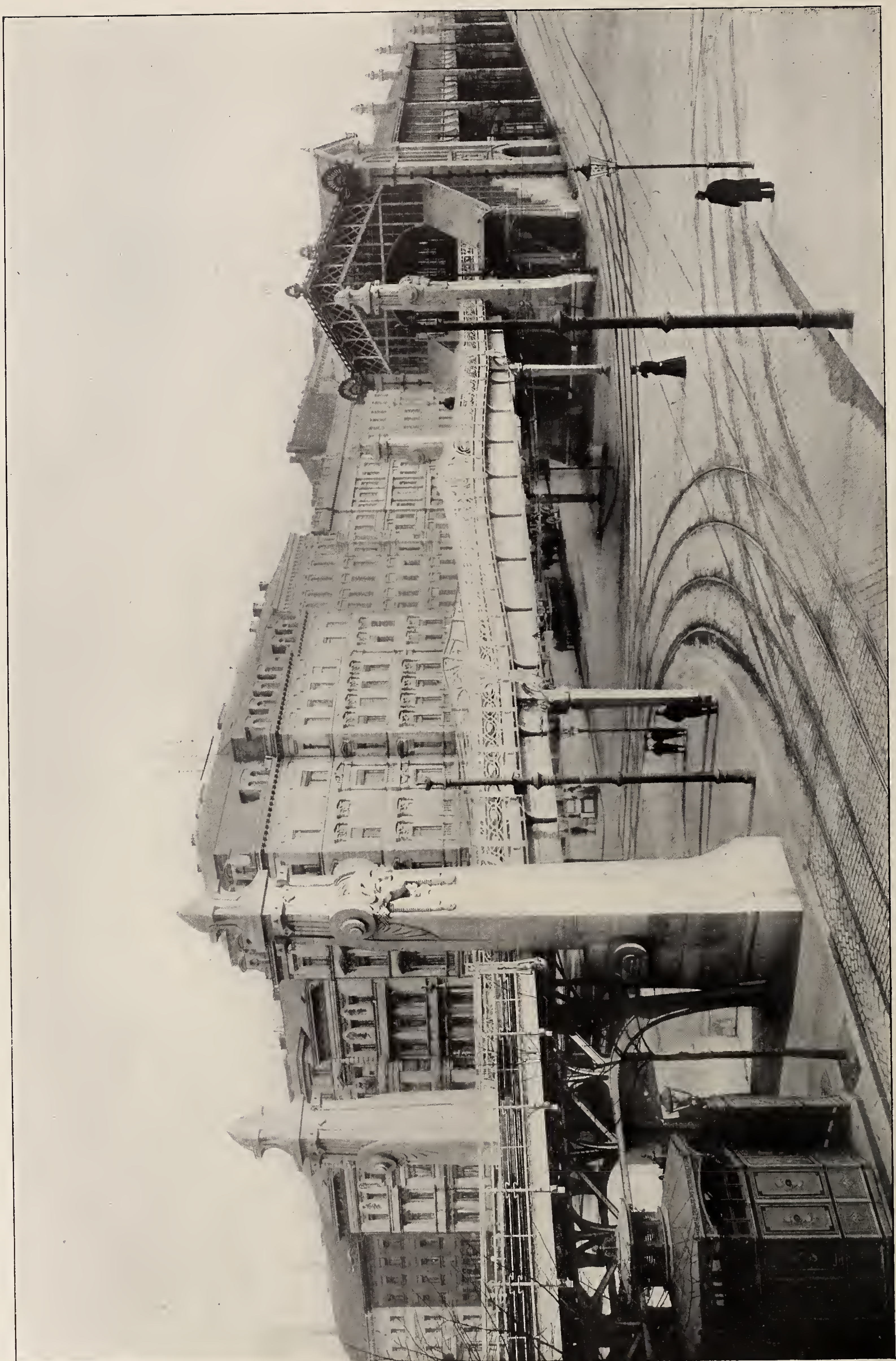


FIG. 32.—THE BÜLOW STRASSE STATION ON THE BERLIN ELEVATED RAILWAY. A GOOD EXAMPLE OF INTELLIGENT CO-OPERATION OF ENGINEER AND ARCHITECT

FIG. 33.—STATION AT NOLLENDORFPLATZ, ON THE BERLIN ELEVATED RAILWAY. THIS STATION IS AT THE DIVIDING LINE BETWEEN THE ELEVATED AND UNDERGROUND PORTIONS OF THE LINE

FIG. 34.—ONE OF THE ENTRANCES TO THE BUDAPEST UNDERGROUND RAILWAY

and second-class compartments, each of which is again divided into smoking and non-smoking compartments. The total seating capacity is 88.

On each of the two two-axle trucks is mounted a 65-H. P. motor. The batteries have a capacity of 300 ampere-hours at 260 volts,—sufficient for three trips between Milan and Monza. A small special battery is provided for lighting. The total weight of these cars is 58 tons, of which 17 tons are chargeable against the battery outfit. This is a large dead weight requiring additional power, and therefore the length of run is very materially limited. While the weight of the battery is a great disadvantage, the storage battery locomotive has many advantages, as it eliminates feeder systems and maintains a steady load on the power station.

Combinations of storage battery and overhead trolley system are also found on the Continent of Europe. The battery is charged from the trolley while the car is running and supplies the power when passing through main streets and public squares. Such systems are found in Berlin, Dresden, Hanover, and Turin. The batteries are usually designed to charge in about ten or fifteen minutes, while the discharge takes about one hour. The batteries usually consists of about 200 cells with a capacity of 25 ampere-hours.

In addition to these systems there have existed for several years in France and Germany systems of trackless trolley vehicles. These are reported to be quite successful, although the writer understands that the power required by them is about double that necessary in the ordinary systems; but it must be remembered that the expensive and sometimes objectionable rails in the streets or on country highways are done away with by this system. This is an important item in their favour.

HIGH-TENSION CONTINUOUS CURRENT, AND SPECIAL MOTOR GEARING

A very interesting railway is that between St. Georges de Commiers and La Mure, in Southern France, a distance of 25 miles. The locomotives operate on a direct-current double-trolley system at 1200 volts. (See Fig. 38.) The system is intended for heavy duty, as it operates in the coal mine district of La Mure. The line was installed by Compagne de L'Industrie Electrique et Mecanique, famous for their many experiments with high-tension direct current.

Each of the locomotives develops 500 H. P. and weighs 50 tons, and is capable of hauling 100 long tons at a speed of 15 miles per hour. As will be noticed, there are four sliding-bar contact trolleys, each supplying one of the four 125-H. P. motors, which are geared to the drivers. These motors are connected two in series, each working at a potential of 1200 volts.

The size of car motors is limited by the available space between the axles and the car body, and it has seemed strange to the writer that no device should have appeared for operating the cars by a worm and wheel gearing, thus allowing the motor to be located at the side of the truck with its shaft at right-angles to the axles.

A motor car with this type of transmission, however, has lately been mentioned as being recently introduced by the Oerlikon Works. The interesting feature of this type of car has been stated to be that the motor and other operating mechanisms lies outside of the car wheels, thus enabling easy inspection without removing the floor or employing an inspection pit,—a feature which is of great value especially with large rolling stock.

Each motor operates one axle by means of a worm and wheel running in a closed oil chamber. The worm is joined to the motor shaft by means of a flexible coupling. Excellent results are said to have been obtained with this system.

HIGH-TENSION, THREE-PHASE TRACTION

The advantages of alternating current for operating railroads were early recognized by Continental engineers. This is evidenced by the alternating-current lines in successful operation at present. One of the best examples is the now well-known Valtellina line in Italy.

The electrification of the Valtellina railroad covered only 60 miles, but its extension is at present being considered. The system consists of three-phase alternating current with two overhead wires, the rails acting as the third conductor. The voltage at the power house is 20,000, and the frequency 15 cycles. The voltage is transformed to 3000 volts at the substations, the greatest distance between any two of which is about 12 miles. There are at present in operation a number of motor cars and locomotives for passenger as well as freight service, so that the entire steam equipment is done away with.

One of the earlier locomotives for freight service is shown in Fig. 39. It is of the double-truck, four-axle type, each axle being equipped with one high-tension motor, having a continuous capacity of 150 H. P. This locomotive has a total weight of 46 long tons and a draw-bar pull of 17,000 pounds.

Three new locomotives, however, have since been designed for two different speeds, 18½ and 31 miles per hour. One of these is shown in Fig. 40, standing at the station of Lecco.

As the Italian company desired, these locomotives are designed with six driving wheels, between which four motors are mounted. This lo-

comotive has a continuous capacity of 800 H. P., which may be increased to 1200 H. P. for one hour, and to 1600 H. P. for a short time. The windings are so designed that they will stand a tension of five times the normal value, viz., 15,000 volts. One of these locomotives is capable of accelerating a train of 400 long tons from 0 to 18½ miles per hour up a 1 per cent. grade in 55 seconds, while a train of 250 long tons may be accelerated on the same grade from 0 to 37 miles per hour in 110 seconds, this with a potential of only 2700 volts.

The results obtained on this road are most creditable to Messrs. Ganz & Company. After several years of operation, the operating company reports that whatever failures have been detected have been in regard to mechanical parts, such as bearings, for example, while the electrical features have produced excellent results with the exception of a few minor details, such as lightning arresters on the trolley lines, etc. The great advantage of pumping back into the line when descending grades or braking has proven entirely satisfactory in this case.

The current is supplied to the motors through a cylindrical roller contact with two sections, insulated at the center, so that current from the different phases will pass down the two legs. Very satisfactory results have been obtained with this device, and on account of the fact that it does not leave the trolley wire it is particularly well adapted for use on high-speed lines or with long spans. A novel feature is the adoption of compressed air for operating switches, rheostats, the trolley, and all apparatus for controlling the locomotive.

The fears entertained in regard to the use of high-tension voltage for this kind of work have proven groundless, as during the years of operation of this line only one fatal accident chargeable to electrical causes has occurred, and this was in a transformer station where 600 volts would probably have been as fatal as the 20,000.

FIG. 35.—A STATION ON THE VIENNA BELT LINE

FIG. 36.—THE EMPEROR'S STATION ON THE VIENNA ELECTRIC BELT LINE

SINGLE-PHASE RAILROADS

Single-phase operation, the latest in electric traction, is being pushed vigorously on the Continent of Europe. As in the case of the polyphase roads, this system was first commercially introduced on the Continent, and there are to-day a number of such lines in successful operation, and several also in course of construction.

The single-phase line of Nieder-Schöneweide - Johannisthal - Spindlersfeld, near Berlin, has been in regular operation since July, 1904, and was built by the Union Electrizitäts Gesellschaft, of Berlin. The trains consist of two trailers placed between two motor cars. The potential employed is 6000 volts at a frequency of 25 cycles, the cars being equipped with alternating and direct-current motors suitable for a train speed of 25 and 37 miles per hour. Current is taken by sliding-bow contact from an overhead wire supported by double-catenary suspension, thus giving greater safety and increased lateral rigidity.

The Oberammergau road in the Bavarian highlands starts at Murnau, in the Loisach Valley, transferring the passengers of the Bavarian State Railway, after a run of some 14 miles to the town of Oberammergau. The overhead trolley is supplied with current at 5000 volts at a frequency of 16 2-3 cycles per second. It was thought that the high voltage would be objectionable, and therefore in the car barns only 260 volts are used. Each car is provided with two sliding-bow contacts. This road was built by the Siemens-Schuckert Company.

Another very interesting single-phase road is that in the Stubai Valley, in Tyrol. This road has been in operation since August 1, 1904, and

FIG. 37.—A STORAGE BATTERY MOTOR CAR FOR ITALIAN SERVICE, BUILT BY THE SIEMENS-SCHUCKERT WORKS, BERLIN

connects Innspruck, the capital of Tyrol, with the small industrial town, Fulymes. It is 11½ miles long and has many grades, the steepest of which is 4.6 per cent., while the shortest curve has a radius of 130 feet. This road is in use for both passenger and freight service. The 11,000-volt transmission current is stepped down to 2500 volts, at which pressure it is supplied to the trolley wire. Each motor car is equipped with four 40-H. P. motors connected in parallel and operated by special controllers. The trains are made up of a motor car and two trailers. The motor cars are provided with two sliding-bow contacts.

One of the most novel features in single-phase railroads is the Huber current-collecting device brought out by the Oerlikon Works. As it is considered that the trolley wire is better located at the side rather than directly over the track, the motor car or locomotive is equipped at either side with the current-collecting device shown in Figs. 41 and 42 carrying a bent rod which may slide either above, below, or at the side of the trolley wire, depending upon the location of the latter. The mechanism is such that the rod may be revolved about a center and be pressed against the wire by a spring. In putting the collector out of action, a wheel is operated in the car, which pulls the rod downward to the roof. The apparatus allows of any switching or crossing, as it may occur in heavy freight or passenger service.

MARIENFELDE-ZOSSEN EXPERIMENTAL RAILWAY

For solving the problem as to how far the electrification of trunk lines could be carried successfully, and how great a speed could be obtained, the Studien-Gesellschaft für Elektrische-Schnellbahnen was formed in Germany. It is made up of a board of eighteen directors,—members of the foremost German companies, and twenty-nine technical members.

This society is supported by the Prussian Government, and as the roadbed forming part of the military railway system was found to be unsuitable for speeds in excess of 75 miles per hour, it was rebuilt by the Prussian "Railway Corps,"—a body

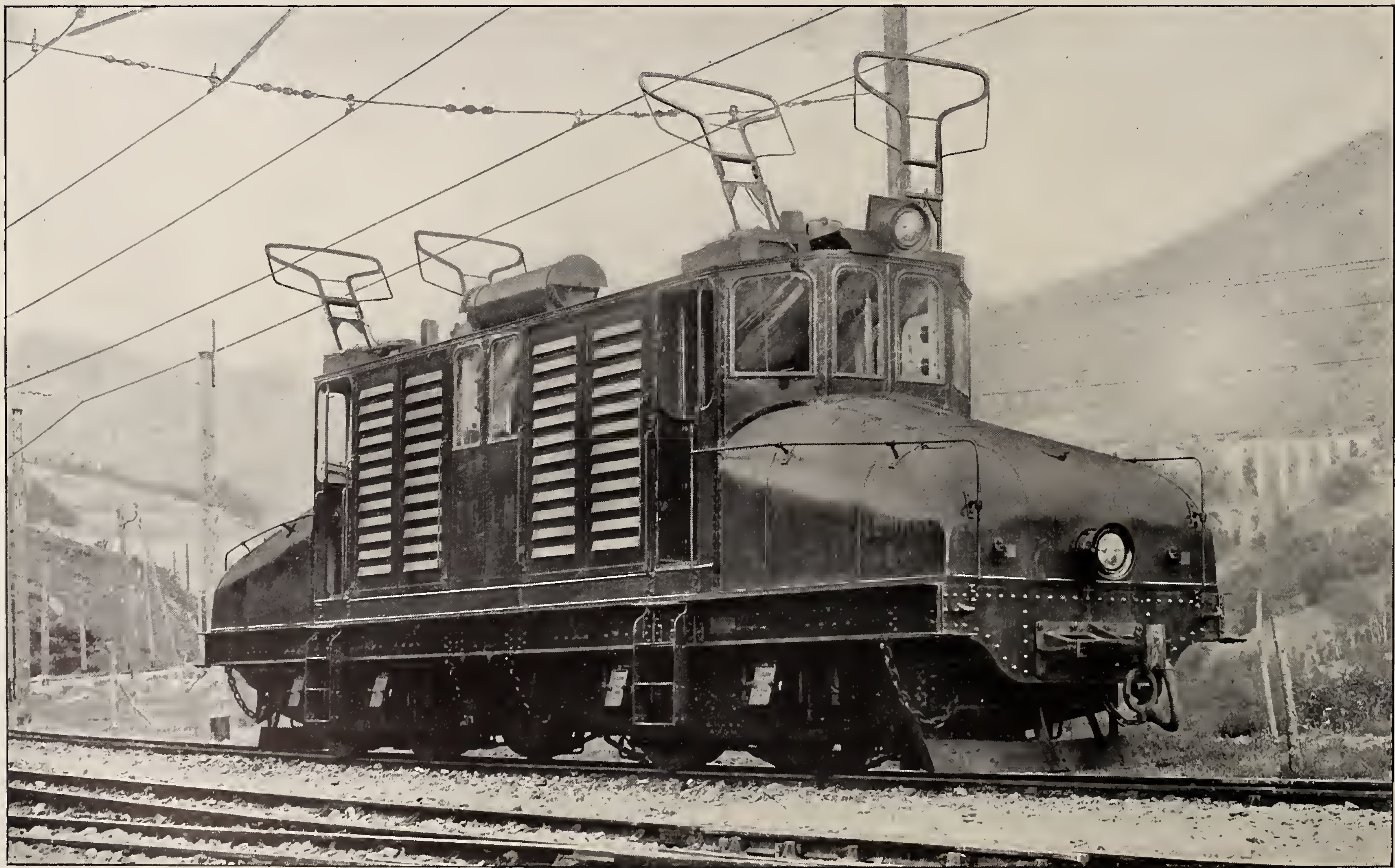


FIG. 38.—A 50-TON ELECTRIC LOCOMOTIVE FOR HEAVY, SLOW-SPEED, COAL-TRAIN SERVICE BETWEEN ST. GEORGES DE COMMIERS AND LA MURE, FRANCE. THERE ARE FOUR BOW TROLLEYS TAKING CURRENT AT 1200 VOLTS FROM TWO OVERHEAD WIRES. BUILT BY THE ELECTRICAL & MECHANICAL INDUSTRIAL COMPANY, GENEVA, SWITZERLAND

of soldiers especially trained in general engineering work and railway construction. One hundred-pound rails were laid down together with guide rails on cast-iron supports. This construction is clearly shown in Fig. 45.

The Siemens-Halske Co., of Berlin, having previously experimented with high-speed locomotives, built a new electric car, and another was furnished by the Allgemeine Electrizitäts Gesellschaft, of Berlin, shown respectively in Figs 43 and 44. These cars differ in minor details only; the bodies are 65 feet long by 9½ feet wide, and are divided into three compartments suitable for the high-potential apparatus, measuring devices, and the passengers. The car bodies are supported on two six-wheel trucks placed 43½ feet apart, center to center. The total weight, including passengers, is about 100 tons.

Three-phase alternating current at 15,000 volts was chosen for the speed trials, and the Siemens-Schuckert Company built a special overhead trolley system consisting of three wires placed one above the other at the side of the track, supported by U-shaped brackets on wooden poles. The side location was chosen for the wires so as to facilitate repairs without interfering with the traffic.

The car shown in Fig. 44 was equipped with two groups of three current-collecting devices, separately mounted upon the car roof, while the car shown in Fig. 43 had two rigid upright booms, upon which were mounted three collecting devices. The sliding-bow contacts in both cases are slightly pressed against the wires, and may be turned to the other side from the interior of the car.

Dr. W. Reichel, one of the formost German authorities, who experimented with the Siemens-Halske car, stated before the "Elektrotechnische Verein," of Berlin, that the sliding contact was the most favourable for high-speed traction, and that where a speed of less than 50 miles per hour was sufficient, the old system of supporting the trolley directly overhead with a common bow contact might prove satisfactory. Numerous tests were made under all conceivable conditions of track, trucks, car bodies, current-collecting devices, electric equipment, and wind resistance. Mr. Chas. Mudge, formerly chief engineer of the Allgemeine Electrizitäts Gesellschaft, of Berlin, in a recent paper before the New York Electrical Society on the tests of their high-speed car, said:—

"Basing our ideas upon some of the observations and experiences gained in these tests, we would make use of the following points in approaching a similar problem:—(1) Keep the car body as near the rails as possible. (2) Arrange all heavy pieces of apparatus so that their centers of gravity lie in the center of the car, or symmetrically placed to it, and as near the earth as possible. (3) All apparatus mounted above the car floor should be as light as its design will permit. (4) Make the overhead trolley contact above the car in preference to the side of the car. (5) Support the motors flexibly on the axles of the trucks. (6) Give the front end of the car a wedge shape. (7) Support the car body on the truck frame at some distance from the center bolt, and allow flexibility in a line at right-angles to the track, independent of the truck. (8) Make the total wheel base of the trucks of ample dimen-

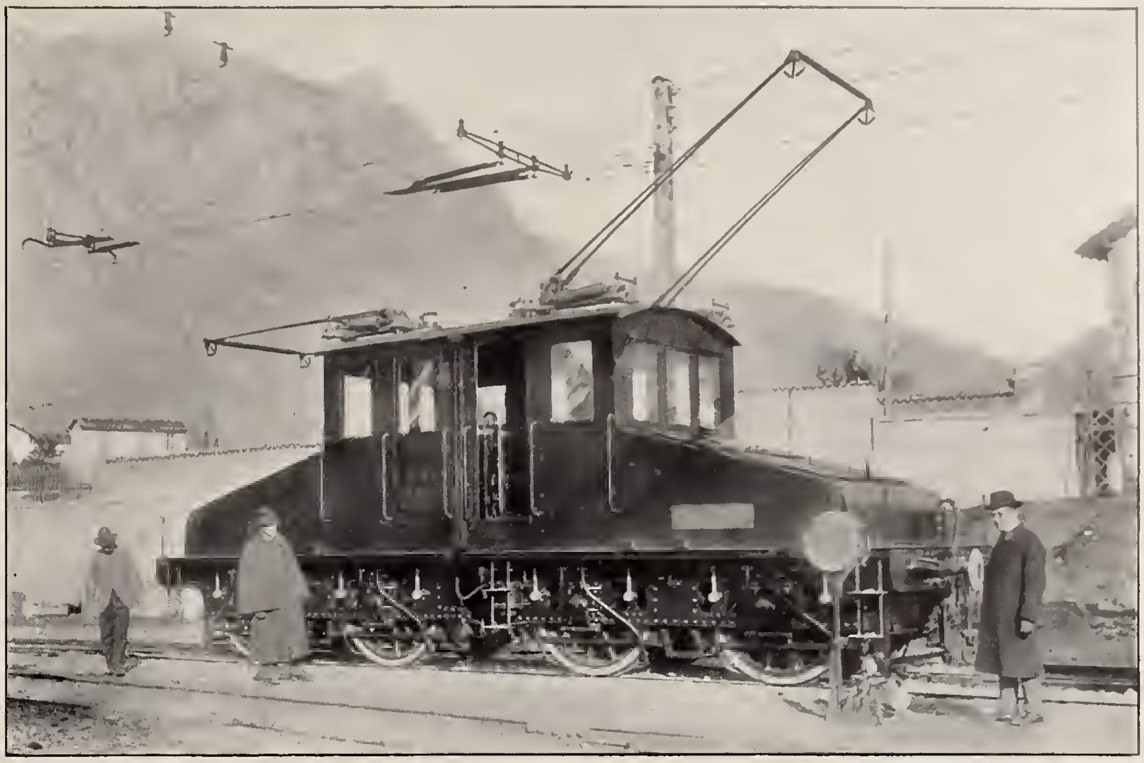


FIG. 39.—ONE OF THE EARLY THREE-PHASE LOCOMOTIVES ON THE VALTELLINA LINE BUILT BY MESSRS. GANZ & COMPANY, BUDAPEST

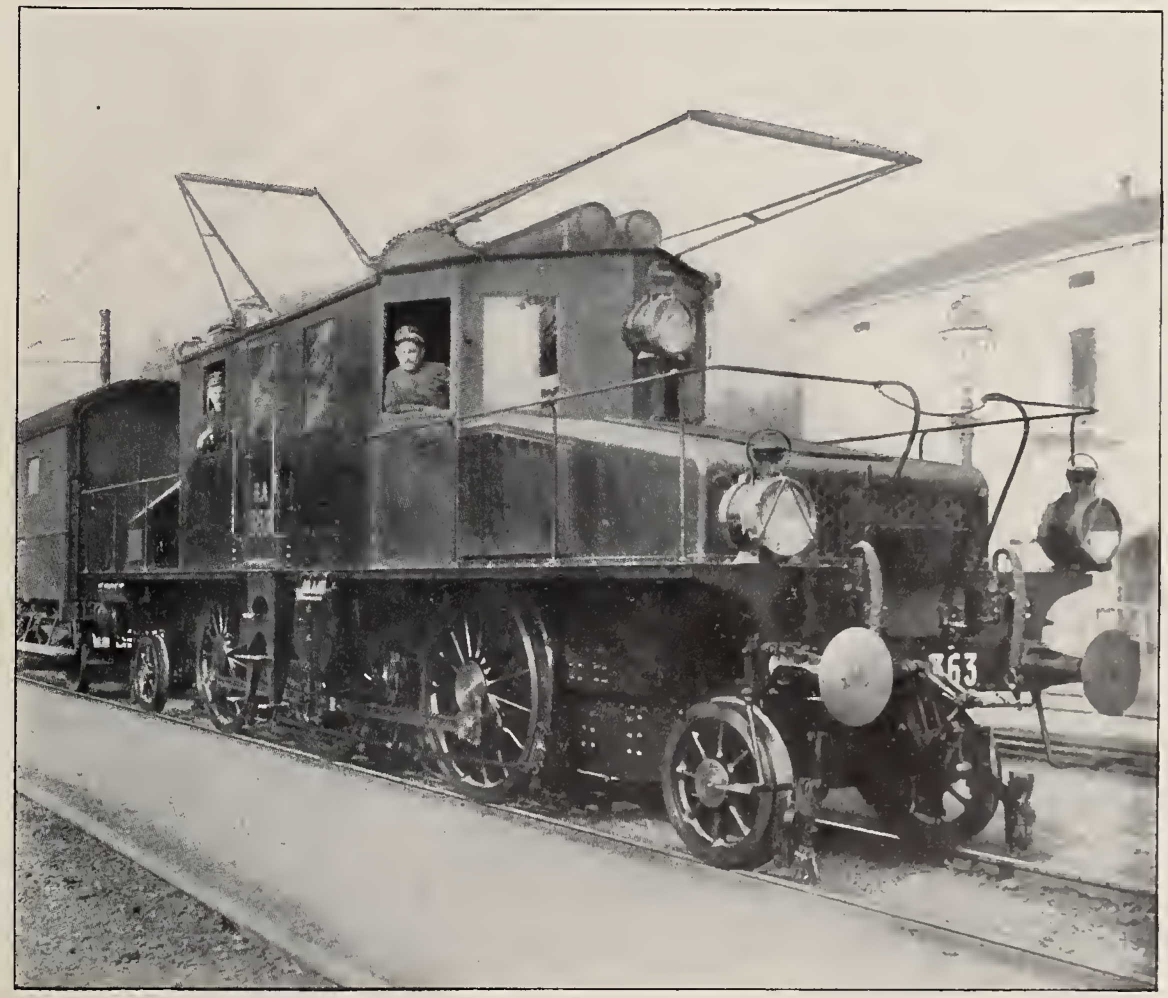


FIG. 40.—ONE OF THE NEW THREE-PHASE LOCOMOTIVES ON THE VALTELLINA LINE. BUILT BY MESSRS. GANZ & COMPANY

FIG. 41.—A SINGLE-PHASE LOCOMOTIVE EQUIPPED WITH THE HUBER CURRENT COLLECTOR MADE BY THE OERLIKON WORKS

sion, and not less than 20 per cent. of the length of the car. (9) Build the road as straight as possible, and where more than one track is used, place them further apart than present practice would suggest. (10) On curves, make the approach of the elevated side of the track longer than usual."

More than 300 experimental trips were made without a single accident. With both cars, speeds up to over 131 miles per hour were reached.

FIG. 42.—A NEAR-BY VIEW OF THE HUBER CURRENT COLLECTOR SHOWN ON THE LOCOMOTIVE IN FIG. 41

Ringing Large Bells by Electricity

FOR ringing large bells the ordinary electric bell action, as experience has shown, is unsuitable, not only because of the relatively great amount of energy necessary in the required large sizes of electromagnets in order to accomplish any appreciable mechanical result, but also on account of the trouble from the sparking of the contact maker.

Some interest is, therefore, attached to a recent German description of a number of large electrically operated bells in which a small electric motor does the work. The motor drives a worm and wheel gear, and a pinion on the axle of the wheel is geared into a large spur wheel on which are four projecting bosses. As these revolve they engage with a ratchet on a lever, at the end of which is a wire to which the hammer of the bell is attached. The lever is fixed in such a position that the hammer of the bell almost touches the gong. It is then drawn away by the gear described above, and on being released, the hammer strikes the gong, giving a very loud signal. These bells, it is stated, are being used largely for railway signaling and for sounding alarms at level crossings. They are also employed at manufacturing works for time-signaling purposes. As the motors are not run for any length of time they require very little attention.

A fire risk inspection of an electric plant, whether it be a power station, sub-station or car house, telephone exchange, or other installation, is something more than a five minutes' task if properly done. Many times an inspection fails in its intended purpose simply because the employee charged with the duty does not know what to look for. A glance or two around the premises reveals a few fire extinguishers solemnly occupying their dusty posts; the wiring looks neat and secure; the motor in the corner of the wood-working shop may be operating within 3 feet of a pile of sawdust, but there is no sign of sparking at the commutator; two or three seedy coils of hose are laid up on convenient shelves alongside a row of dull red half-full water buckets, and so the inspection is complete and another report is stamped approved by the superintendent's stenographer and consigned to the oblivion of the files.

FIG. 43.—THE SIEMENS-HALSKE CAR ON THE MARIENFELD-ZOSSEN LINE

The Association of Edison Illuminating Companies

THE RECENT LAKE CHAMPLAIN MEETING

THE twenty-sixth convention of the Association of Edison Illuminating Companies was held at the Hotel Champlain, at Lake Champlain, N. Y., on September 12, 13 and 14.

No more ideal place of meeting could have been selected than this charming hotel, located on Bluff Point, the most commanding promontory on Lake Champlain, overlooking an unrivaled landscape of mountains, lakes and forests. The grounds consist of 450 acres of beautiful park and woodland, roadways and lawns.

Boating, fishing, shooting, golfing and tennis were freely indulged in by the large number of delegates, acting as efficient depolarizers of their minds after the strenuous hours of discussion. In fact, the elaborate social programme was as carefully considered and carried out as was the business feature, which prescribed papers and discussions during the morning and evening sessions held on each of the three days.

The convention was called to order in the large parlour of the hotel on Tuesday, September 12, at 9:30 a. m. by President Joseph B. McCall, of Philadelphia, who, after a few introductory remarks, read letters from Thomas A. Edison and Samual Insull expressing their regret at not being able to be present. After the presentation of credentials, various convention committees were appointed by President McCall and then the reports of the executive committee and treasurer were read.

John W. Lieb, Jr., chairman of the lamp committee, the other members of which are C. L. Edgar and Samuel Insull, then presented an elaborate report, in which the many recent advances in the lamp industry were reviewed and a 20-candle-power standard was suggested.

The following committees then presented their reports:—

Committee on Meters.—Alex. Dow, chairman; Joseph W. Coles, George Ross Green, A. H. Ackermann, Oliver J. Bushnell, John W. Lieb, Jr.

Committee on National Code.—William C. L. Eglin, chairman; Louis A. Ferguson, Thomas E. Murray.

Committee on Storage Batteries.—Louis A. Ferguson, chairman; William C. L. Eglin, John W. Lieb, Jr., Gerhard Goettling, W. F. Wells.

Committee on Steam Turbines.—William C. L. Eglin, chairman; Fred Sargent, James D. Andrews, C. H. Parker, W. H. Norris.

Committee on Electric Heating.—John F. Gilchrist, chairman; Joseph D. Israel, Arthur A. Pope, Charles H. Herrick, W. W. Freeman.

In the afternoon the entertainment committee, consisting of Charles H. Davis, chairman; Walter H. John-

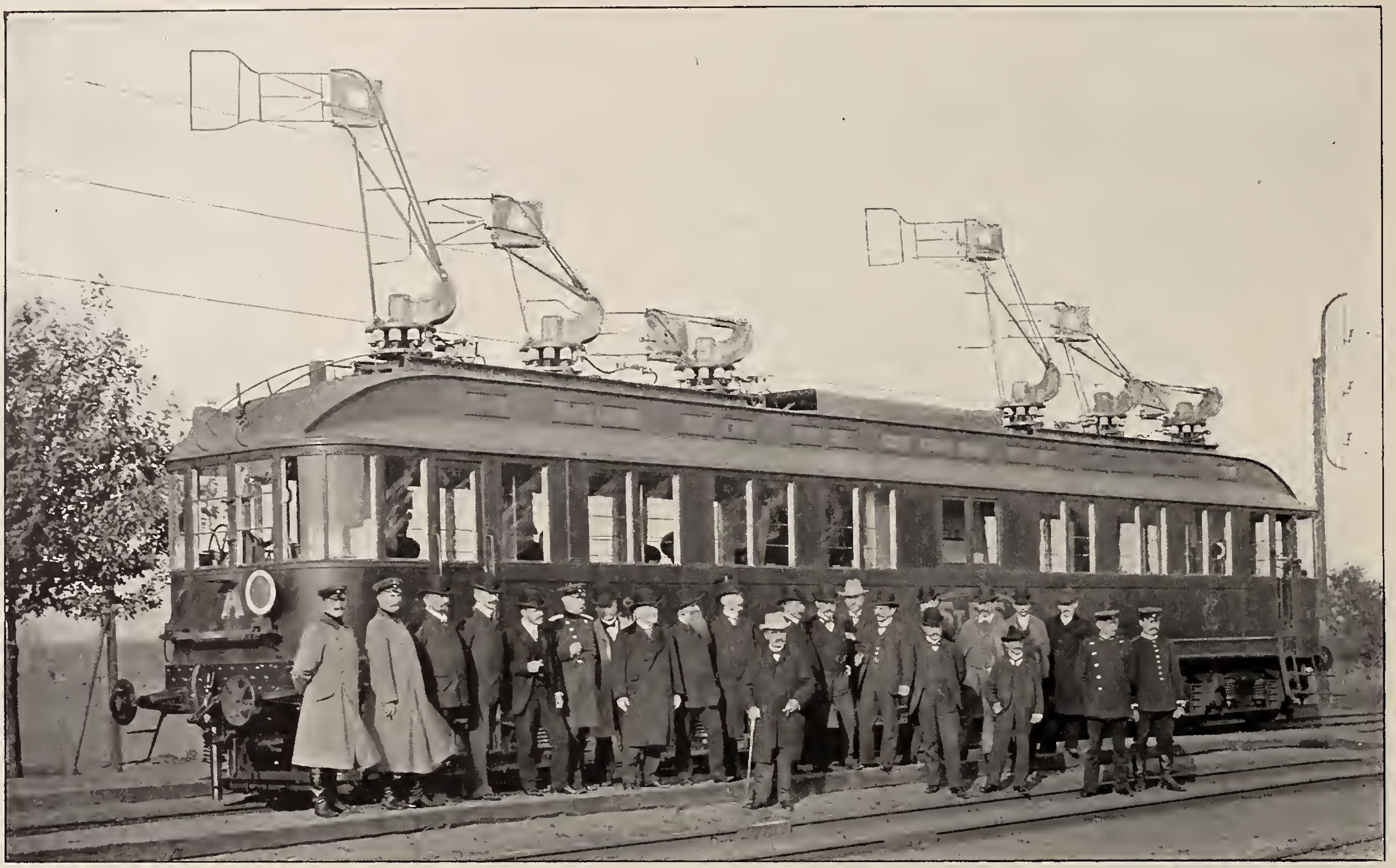


FIG. 44.—THE ELECTRIC MOTOR CAR BUILT BY THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT, OF BERLIN, FOR THE MARIENFELD-ZOSSEN LINE

son, Frank H. Gale, and Howard K. Mohr, provided carriages for the ladies and delegates and a most delightful drive was enjoyed along the celebrated "Green Drive" which skirts Lake Champlain and, passing through the mountains and Plattsburg, leads back into the hotel grounds, being shaded along almost its entire length by immense trees.

The men's handicap golf tournament, which was played over the extensive and magnificently kept golf links, was won by W. C. L. Eglin, of Philadelphia.

On Tuesday evening the following papers were presented:—"Practical Operation of the Nernst Lamp," by W. T. Morrison, of New York; "The Use of Small-Sized Carbons in Alternating-Current Arc Lamps," by G. N. Eastman, of Chicago; "A New Rotative Test Meter," by W. J. Mowbray, of Brooklyn; "Experiences with Tests on all Kinds of Lamps for the Past Year, Including Nernst Lamps," by Dr. C. H. Sharp, of New York.

The ladies and those not participating in the discussion indulged in card games and an informal dance.

At the Wednesday morning session the following papers were presented:—"Practical Experiences with Steam Turbines," by J. A. Radford, of Chicago; "Improvements in Steam Turbines," by W. L. R. Emmet, of Schenectady; "Methods of Starting up Large Interconnected Systems Quickly after Partial or Total Shutdown," and "Instruction and Training of all Operating and Construction Men who Work on High-Potential Apparatus and Connections," by W. F. Wells, of New York; "Relative Advantages of 25 and 60 Cycles," by Philip Torchio, of New York, and W. C. L. Eglin, of Philaphia.

During the forenoon the ladies' handicap golf tournament took place. This was won by Mrs. J. R. Lovejoy. The mixed foursome golf tournament, played in the afternoon, was won by Louis A. Ferguson, of Chicago and Mrs. Alex. Dow, of Detroit.

In the evening the following papers were read:—"Magnetite Lamps and Mercury Vapour Arc Lamps and Mercury Arc Rectifiers in Connection with Electric Light," by Dr. C. P. Steinmetz, Schenectady; and "The International Electrical Congress at St. Louis," by J. W. Lieb, Jr., of New York. A discussion of the report on Electric Heating followed. The convention was addressed on this subject by Max Loewenthal, of New York.

The ladies were entertained by a professional elocutionist, and the ladies' croquet tournament, which was held during the evening, was won by Mrs. Davis, of Boston. Dancing was indulged in, and small parties gathered in the beautiful grotto and gardens until a very late hour.

At the Thursday morning session the following papers were presented and discussed:—"Coal Handling and Storage of the Edison Electric Illuminating Company of Boston, at the South Boston Station," by Chas. H. Parker, of Boston; "Notes on Sale of Electric Power," by E. W. Lloyd, of Chicago; "The Relation of the Central Station to the Motor-Driven Refrigerating Machine," by G. W. Goddard, of Philadelphia; and "The Relative Merits of Discharging Batteries in Edison Systems through Reversible Boosters and through End-Cell Switches," by Gerhard Goettling, of Boston.

The following officers were elected for the ensuing year:—President, Joseph B. McCall, of Philadelphia; vice-president, D. L. Huntington, of Spokane, Wash.; treasurer, Alex. Dow, of Detroit, Mich.; secretary, G. R. Stetson, of New Bedford, Mass.; assistant secretary, H. C. Lucas, of Philadelphia. All of the old officers were thus re-elected, with the exception of the secretary, Mr. Stetson

being elected to take the place of E. A. Leslie, deceased. The convention then adjourned.

The ladies' golf putting contest was won by Mrs. J. R. Lieb, Jr., of New York. In the afternoon there was a tally-ho party to the Plattsburg County Fair and a pleasant afternoon was spent. Numerous pools were made up and much innocent betting was indulged in on the various racing contests.

In the evening there was a dance at the hotel. During an intermission President McCall requested Mr. Dow, of Detroit, to present the prizes to the winners of the various contests, and this duty was performed with much humour and grace. All the prizes were presented, as has been the custom for some years, by the General Electric Company.

Those who did not return to their homes the next morning, accepted the invitation of President and Mrs. McCall to take a trip to Au Sable Chasm, one of Nature's marvels, by special boat and train, and this excursion was thoroughly appreciated by many.

The convention, from a business as well as social standpoint, was attended by about 200 delegates and members of their families. The General Electric Company was represented by Gen. Eugene Griffin, first vice-president; E. W. Rice, Jr., third vice-president; J. R. Lovejoy, general manager of the lighting department; Dr. C. P. Steinmetz, chief engineer; J. R. McKee, manager of the power and mining department; B. E. Sunny, Western manager, and Messrs. W. L. R. Emmet, G. E. Gilbert, C. D. Haskins, F. H. Gale, H. W. Hillman and P. D. Wagoner, of Schenectady; C. B. Davis and F. M. Kimball, of Boston; T. Beran and F. C. Bates, of New York; John W. Howell, F. R. Willcox and G. H. Morrison, of Harrison, N. J.

As a proof of the growing interest manifested in electric heating by central station men, an exhibition of various types of electric heating apparatus was arranged in the basement of the hotel, the General Electric Company showing its two systems, the one employing the cartridge unit and the newer form having the heating wire embedded in quartz. The exhibit was presided over by Messrs. Hillman and Andrews. The American Electric Heater Company, of Detroit, showing a full line of its product was represented by its president, B. H. Scranton.

Six trackless trolley systems are now in active operation in Germany.

FIG. 45.—ROADBED ON THE MARIENFELD-ZOSSEN LINE, NEAR BERLIN

The Allis-Chalmers Company's Report

THE report of the Allis-Chalmers Company, made public early last month, covers the fourteen months ending June 30, 1905, the end of the fiscal year having been changed from April 30 to June 30. The consolidated profit and loss account for the fourteen months, including the receipts of the Bullock Electric Manufacturing Company for sixteen months ending June 30, shows profits on operations, after deducting expense of manufacturing and selling and provision for bad accounts, of $1,146,981.

For maintenance, repairs and renewals on buildings and machinery the expenditures were $752,860, and there were charged off for depreciation $325,139, making the total $1,077,999. The net profits were thus $68,982, which compares with net profits of $952,624 for the twelve months ending April 30, 1904. Adding $68,982 to the balance of $624,835 on April 30, 1904, gives $693,817. From this are deducted $345,528 for special expenditures during the year, leaving the surplus on June 30, 1905, at $348,289. The additions to plant in the fourteen months were $303,685, less $14,000 received for real estate sold, making the total capital expenditure for the fiscal period $289,685.

President B. H. Warren in his report says:—

"All the property of the company is owned in fee except the Bullock Electric Works at Norwood, near Cincinnati, Ohio, which are held under a long lease. The entire property of the company is free from mortgage or other lien. No mortgage can be placed upon the property without the assent of 75 per cent. of the amount of preferred stock outstanding.

"The present manufacturing space and facilities being inadequate, it was decided to make important additions to the West Allis works, and new buildings are now in process of erection. The capacity of this plant will be nearly doubled by these enlargements. Particular attention has been devoted to developing a line of steam turbines, gas engines, centrifugal pumps, hydraulic turbines, steam turbo-generators, hydraulic turbo-generators, induction motors, street railway motors and controlling devices therefor, transformers, steam and hydraulic dredges, and steam shovels. To the already well established line of mining and crushing machinery manufactured by the company has been added a line of steam and hydraulic dredges and steam shovels for heavy excavating and mining work.

"Soon after the commencement of this calendar year an improvement was manifested in the general business of the company, the orders increasing in April to the normal volume and since then exceeding in extent the previous record of the organization; but the results of these orders will be realized only upon their execution and the delivery of the work. This increase pertained more particularly to the older branches of the business of the company.

"The steam turbine rights heretofore acquired by this company have been supplemented in an important manner by further patent acquisitions and alliances, so that it is confidently asserted that this company is now prepared to place upon the market steam turbine and turbo-generating units that will enable it to retain its position as a leading manufacturer of steam engines of the most successful types. The works are now engaged in filling one of the largest single orders for steam turbines that has ever been placed in this country, the installation of which will be completed by the end of the present calendar year. A number of important contracts for hydraulic turbines have also been secured."

Natural Gas near Salt Lake City

ACCORDING to a just-issued bulletin of the United States Geological Survey, natural gas occurs at a number of localities along the eastern shore of Great Salt Lake, notably in the vicinity of Brigham and Corinne, near the mouth of Bear River, and in the vicinity of Salt Lake City, adjacent to the mouth of Jordan River. Near Salt Lake City gas has been found in an ill-defined area, extending at least 10 miles west of the city and 15 miles north, as far as Farmington. This area was formerly occupied by Lake Bonneville, the Pleistocene predecessor of Great Salt Lake.

Though gas has been found in numerous wells within this area, the greatest development has occurred about 12 miles north of Salt Lake City, in the marshy tract near the shore of Great Salt Lake. Gas is reported to have been discovered in this region in 1892, and in the winter of 1894-5 a 6-inch pipe line was laid to Salt Lake City. In an area of only 1 square mile, about 20 wells were sunk. Gas occurs at different depths in the area developed, but mostly between 400 and 700 feet. In one well three gas horizons were struck, at 502, 542 and 602 feet. In another well, 800 feet deep, nine "good, strong flows" of gas are reported. The gas is said to occur in sand which is underlain and overlain by clay, the beds ranging from 3 to 20 feet in thickness. The productive sands are reported generally free from water, although small artesian flows were found in overlying beds. The pressure of the gas in the wells is said to have averaged about 200 pounds, and the maximum pressure of 250 pounds has been recorded.

An Early Method of Laying Underground Wires

ABOUT fifty years ago, said D. A. Harrington, before the Boston Society of Civil Engineers, it was proposed to lay a line of underground wires on one of the railroads in Massachusetts. A car was equipped with a plow projecting at one side, at the front end, to open up a furrow parallel with the tracks; a reel of wire was placed on the car with apparatus for feeding the wire into the furrow, and at the rear end of the car was fastened an implement for throwing the dirt into the furrow, covering the wire. Thus, while the train was in motion, the trench was dug, the wire laid and the trench refilled all at one process. This would rather seem to put to shame our present method if the work had been permanent, but, unfortunately, this was not the case.

In a paper dealing with the necessity of inspection of electric wires, read at the recent annual meeting of the International Association of Municipal Electricians, T. C. O'Hearn, city electrician of Cambridge, Mass., directed attention to the unfortunate tendency to believe that once an installation has been connected to the service mains it is no longer to be considered under the control of the inspection department. By far the larger number of accidents from electrical wiring are caused by defects in old wiring,—defects caused by accident, wear and tear, and amateur work done after the final inspection. The only way to offset these accidents is to carry on a course of periodical inspections with a view of remedying the defects. This means a larger force in the inspection department, but there is no doubt that the results would warrant the increased expense. Mr. O'Hearn said he knew of no place where this is done except in theaters and large department stores in the larger cities.

THE ELECTRICAL AGE

Established 1883

Volume XXXV Number 5
$2.50 a year; 25 cents a copy

New York, November, 1905

The Electrical Age Co.
New York and London

A Large Steam Turbine Generator

By B. A. BEHREND, Chief Electrical Engineer, Allis-Chalmers Company

IT is only a short time ago that the installation of a number of 5000-KW., three-phase generators in the power houses of the Manhattan and Interborough stations, in the city of New York, attracted considerable attention. A few years ago the capacity of these units was considered very large, and the speed of the Corliss engines operating at 75 revolutions per minute made these generators some of the most gigantic machinery in the world.

Since that time the unwearying efforts of engineers have developed the steam turbine which, in regard to speed, represents a position of greatest antithesis to the reciprocating steam engine. From 75 revolutions per minute with the Corliss engine, we are making the immense stride to 750 revolutions per minute in the steam turbine, increasing the speed tenfold. The diameter of the rotating field of the Manhattan and Interborough generators, turning at 75 revolutions per minute, is 32 feet, whereas the diameter of the rotating field of the steam turbine generators operating at 750 revolutions per minute is only slightly larger than 6 feet. That such difference in operating conditions involves a radical departure from standard engineering practice and leads to machines of altogether different design, may be concluded without much investigation.

A generator of 5500 KW., direct connected to a steam turbine, was recently tested at the Bullock Works, at Cincinnati, of the Allis-Chalmers Company. This machine and its performance are interesting on account of numerous novel features as well as on account of the high efficiency, perfect regulation, and low temperature, which have been brought out by the tests. Although the normal rated capacity of this generator is 5500 KW. at either 6600 or 11,000 volts, the generator must be capable of standing 6880 KW. continuously without rising more than 45 degrees C., and 8250 KW. for three hours without rising more than 55 degrees C. On the overload this generator, therefore, will require a prime mover developing 11,500 H.P.

The current developed by this machine has 25 periods, is three-phase, and is generated by a 4-pole magnetic field turning at 750 revolutions per minute. Fig. 2 shows the machine assembled on the test floor; Fig. 1 shows the stationary core or armature; and Fig. 3, the rotating element. Fig. 2 illustrates well the compact design of this machine, due to high speed and the small number of poles; Fig. 1 gives a good view of the thorough lamination and division of the stator core for the purpose of ventilation and cooling; while Fig. 3 shows the most interesting part of the machine, namely, the rotating field.

When we stop to consider that the peripheral speed of the surface of this rotating field is almost 15,000 feet per minute, we realize that we

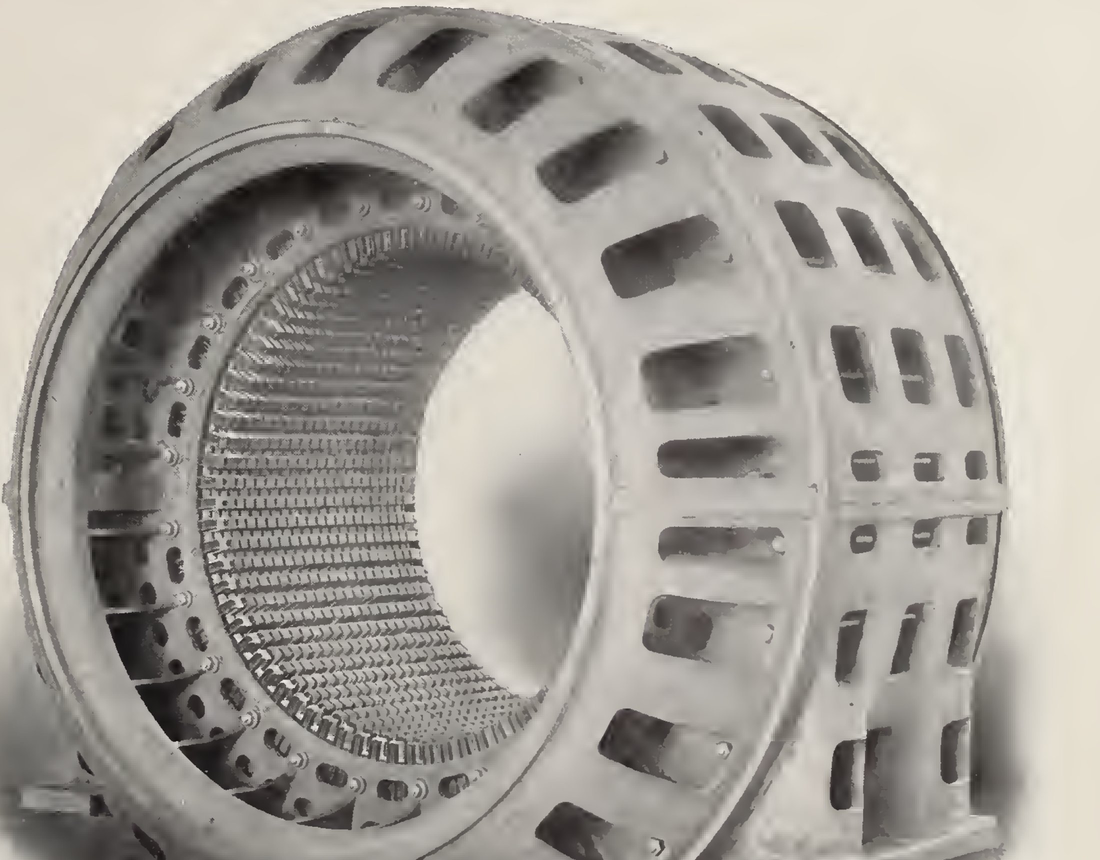


FIG. 1.—THOROUGH LAMINATION AND DIVISION OF THE STATOR CORE OR ARMATURE HAVE BEEN SECURED FOR VENTILATION AND COOLING

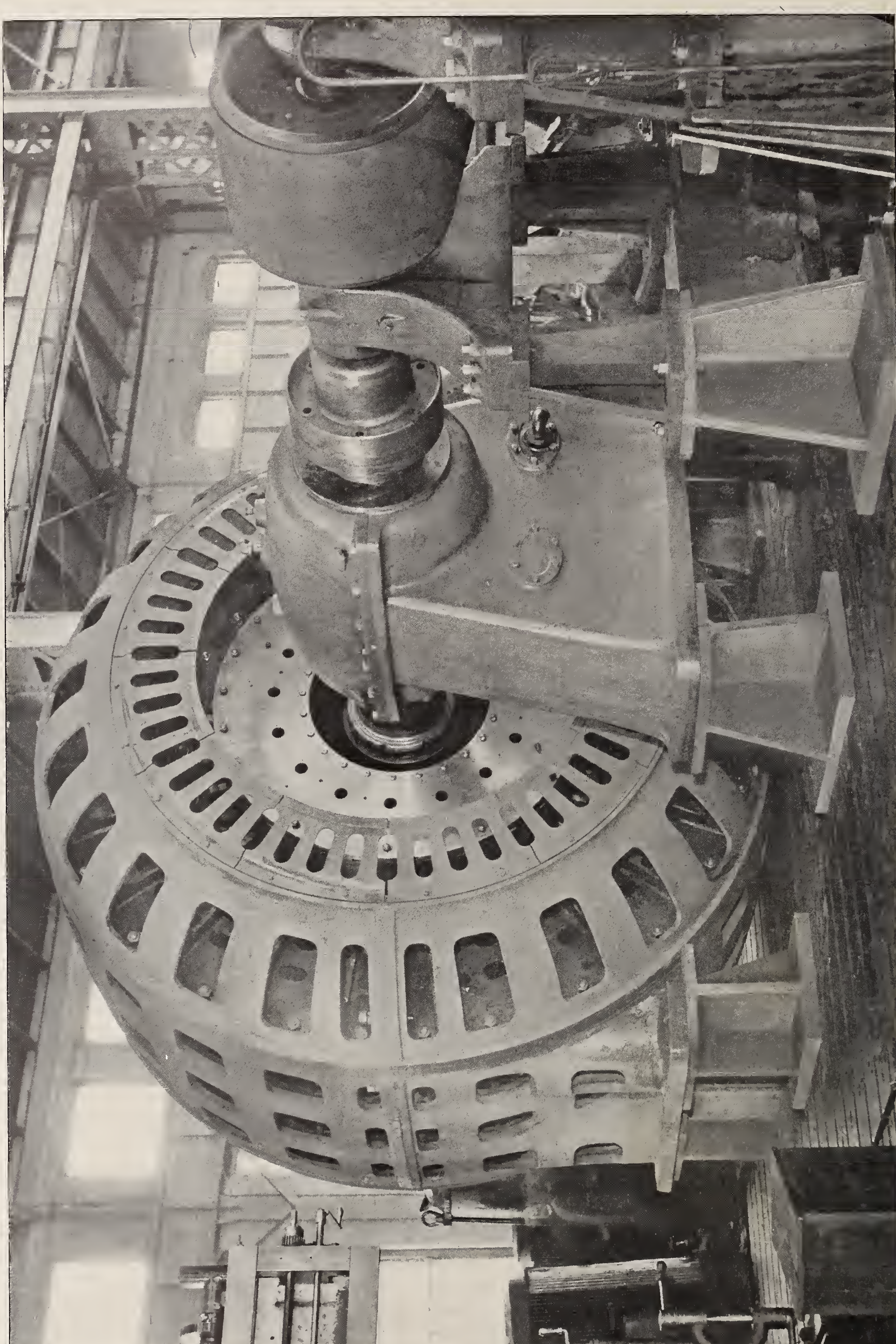


FIG. 2.—A 5500-KW. THREE-PHASE GENERATOR, BUILT FOR DIRECT CONNECTION TO A STEAM TURBINE, AT THE BULLOCK WORKS AT CINCINNATI, OHIO, OF THE ALLIS-CHALMERS COMPANY. HERE SHOWN ON THE TEST FLOOR

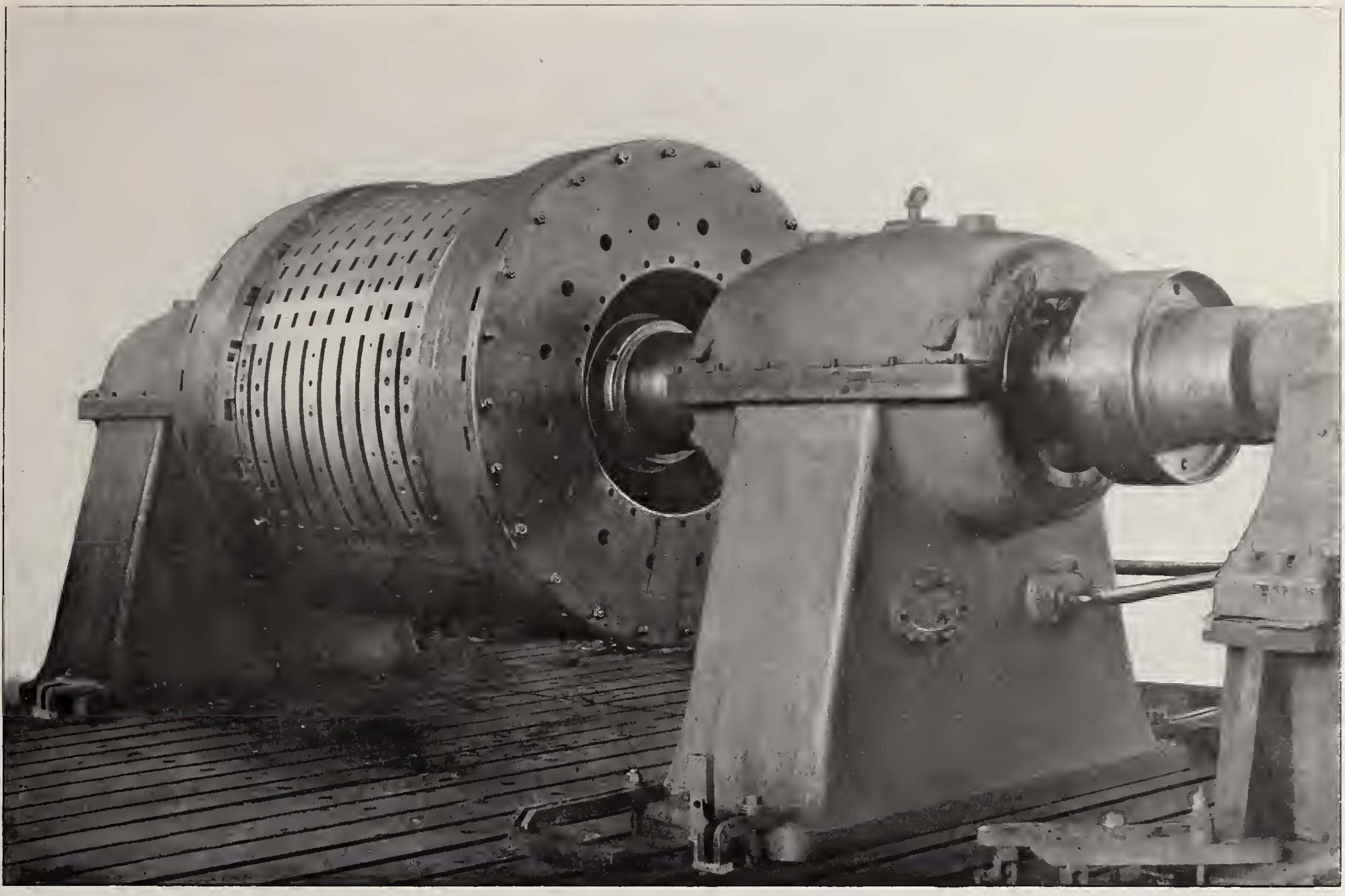


FIG. 3.—THE ROTATING FIELD—THE MOST INTERESTING PART OF THE MACHINE

have before us a problem taxing the designing ability of the engineer to the utmost. If we could proceed, either on railroads or on the ocean, at such speeds as this, we should travel from New York to London in approximately 17 hours.

Under such conditions of speed the centrifugal force assumes tremendous magnitude and the careful distribution and calculation of the stresses and strains in the different members of the rotating magnetic field become a matter of the utmost importance and seriousness. The bursting of a mass of steel, of 75,000 pounds, rotating at the rate of 3 miles per minute, would produce very disastrous effects, and the responsibility of the designer and builder of such machines is, therefore, a very grave matter.

A careful investigation in regard to the stresses and strains produced in rotating discs under the influence of centrifugal force was carried out by the writer several years ago, theoretically as well as experimentally, and it brought forth the interesting result that, in a plain rotating disc, the stresses are a maximum on the inside boundary of the disc and a minimum on the outside boundary. These results, obtained by mathematical analysis, were borne out by experiments on lead discs, the distortion of which was carefully studied by measuring the discs before the speed tests and after, and the distortion corroborated the correctness of the theoretical conclusions.

Rotating discs, therefore, really do "burst" when they go to pieces, that is, they explode in such a manner that they are rent to pieces by forces which tear the fibre of the material, first on the inside, the rents rapidly being transmitted to the outside. This investigation is of considerable interest with regard to the bursting of emery wheels and grindstones, and it throws much light upon the proper and economical design of wheels of any kind, rotating at high speeds. With the aid of the data obtained through these theoretical and experimental investigations, the foundation of design of the rotating elements of these large machines has become well secured, and the determination of the maximum internal stresses in the nickel-steel plates composing the rotating field, illustrated in Fig. 3, can be made with considerable confidence.

The structure of the rotating field consists of ten nickel-steel forgings pressed on a nickel-steel shaft. In order to obtain both high magnetic permeability and good mechanical strength, nickel-steel, containing approximately from 3 to 5 per cent. nickel, has been used whose lowest elastic limit is 50,000 pounds per square inch and whose lowest ultimate strength is 80,000 pounds per square inch. The highest stress existing in any one part of the rotating element does not exceed 15,000 pounds per square inch. At normal speed, therefore, the lowest safety factor is almost $5\frac{1}{2}$, showing that these rotating fields might be run at twice their normal speed without flying assunder.

A problem of extreme difficulty confronts the designer in placing and securely fastening the field windings to these large steel blocks in such a manner that neither the copper conductors nor the insulation between them and the magnetic field can be injured by the centrifugal force to which they are exposed. To this end flat copper strips have been wound on specially designed formers, which are made in such a manner as to give an ever-increasing opening to each successive turn, and they are lodged in radial slots, milled into the nickel-steel discs, and held in place by retaining wedges made from Par-

sons manganese bronze. The construction is so solid that it might well be said that a cannon could not be made stronger and more reliable. The end connections of the field coils rest against nickel-steel end rings, which also are shown in Fig. 3.

Owing to the rotation of the revolving field, air is blown through the ventilating segments of the stator, cooling the core as well as the coils. The efficiency of this ventilation is well demonstrated by the fact that, though operating at a core loss of 47 per cent. above the normal, the temperature rise of the core, after continuous operation, did not exceed 22½ degrees C., and this result was obtained with comparative little noise and power. The satisfactory ventilation of the field coils has also been demonstrated.

The electrical efficiency of this generator, as actually obtained from tests, is 94.4 per cent. at ¼ load; 97 per cent. at ½ load; 97.9 per cent. at ¾ load; 98.3 per cent. at full load; 98.5 per cent. at 1¼ load, and 98.6 per cent. at 1½ load. The regulation of the generator at full load at 100 per cent. power factor is 7½ per cent., and yet the generator has enough margin to give its full rated output on any power factor, however low.

Another question of great importance in the design and operation of the high-speed revolving-field generators is created by the tendency towards vibration which, in improperly designed machines, may become a source of very serious difficulty. The heavy mass of the rotor, put on a shaft, corresponds exactly to the mathematical combination of a mass and a spring attached thereto, which is the simplest form of a vibratory system. Such a system, by alternately yielding up and storing energy, is capable of vibrating violently under certain conditions favourable to the existence of such vibrations, and it becomes a problem of paramount importance to determine the natural period of vibration of the rotating element of a generator operating at such high speeds as the large machine here described.

By carefully studying this problem and choosing such dimensions for the shaft of the machine as will correspond to the natural vibration of the rotating element, as much different as possible from the period of vibration produced by unbalancing at the normal rotative speed, it is possible to obtain safe and steady operation without fear of vibration. To steer clear among the many reefs that beset the course of the engineer in the creating of large apparatus designed upon lines heretofore unknown is a problem all the more interesting because of its difficulty.

The Coldest Liquid Known

LIQUID hydrogen is by far the coldest liquid known at the present time. At ordinary atmospheric pressure it boils at 422 degrees F., and reduction of the pressure by an air pump brings the temperature down to 432 degrees, at which the liquid becomes a solid, resembling frozen foam. According to Professor Dewar, to whom the credit is due of having liquefied hydrogen in 1898, the liquid is a colourless, transparent body, and is the lightest liquid known to exist, its density being only one-fourteenth that of water; the lightest liquid previously known was liquid marsh gas, which is six times heavier. The only solid which has so small density as to float upon its surface is a piece of pith wood.

In a paper read before the Ohio Electric Light Association, Professor Ambler described tests as to distribution of light from the tantalum lamp with both clear and frosted bulbs, and comparisons made with the light distribution from a 16-candle-power, 110-volt, lamp with clear bulb and with a single coil carbon filament. The results showed that there would be a saving by the use of the tantalum lamp only when the cost of energy was above or about 5 cents per unit. In considering the possible value of the new lamp it was necessary to consider the value of burnt-out lamps. Allowing 50 per cent. of the original cost as the value of the lamp, there was a saving of 35 per cent. in favour of the tantalum lamp with the clear bulb and energy at 10 cents per unit. With energy at 5 cents, the saving amounted to 31.5 per cent., and at 3 cents to 13.5 per cent.

A manufacturer of rubber gloves states that, although testing with water is an excellent way of finding imperfectly made joints, it is useless for detecting grit or air bubbles below the surface. He suggests that these defects in the material be tested for by applying a high-voltage alternating current in water, the potential to be from 5000 to 10,000 volts according to requirements. Each pair should be tested separately and guaranteed, as it is useless to test a sample pair and rate others on the result thus obtained.

Air Resistance of Fly-Wheels

AN interesting bit of investigation was carried out a short time ago at a German electric power station to find out how much power was being lost through fly-wheel air resistance.

Two tandem-compound, 450-H. P. engines, direct connected to generators, and runing at 95 revolutions per minute, were at work in the station, with fly-wheels having arms of channel section which were known to offer great resistance to the air, and on this account it was decided to encase the wheels with sheet iron and stop the evident waste. In order to find out what the loss of energy had been, one of the dynamos was made to serve as a motor for the unloaded engine.

Without the fly-wheel covering there was thus found to be a motor consumption of 13,000 watts, while with the covering in place only about 9900 watts were consumed, showing a saving in this case of 3400 watts, or about 5¾ H. P. The money equivalent of this for a year was far in excess of the cost of covering the fly-wheels. In one other case of this kind, of earlier date, a saving of 30-H. P. was effected in a 630-H. P. engine by reducing this fly-wheel resistance.

In connection with the above it is interesting to note the results of some experiments made several years ago by Professor Charles H. Benjamin, of Cleveland, Ohio, on the bursting of small cast-iron fly-wheels. In these experiments the wheels were simply speeded up to the bursting point. In the cases of a number of wheels which had transverse flanges in or near the rim, however, it was found impossible at first to attain the desired speed. At about 3000 revolutions per minute the speed would remain constant, and no increase of steam pressure could be made to change it.

Becoming convinced that this was due to air resistance on the spokes and cross-flanges of the rim, Professor Benjamin had the wheels closed in with discs of sheet iron, wired together, and revolving with the wheels. After this no further difficulty was experienced, and the bursting speed was reached within two minutes of the time of opening the throttle. Professor Benjamin mentions this as specially interesting because we used to be taught that the air revolved with the wheel and created little resistance. In the case of a 24-inch wheel something like 10 H. P. were absorbed at the maximum attainable speed without the sheet metal casing.

The Installation and Care of Railway Motors

By T. H. SCHOEPF

GENERAL

WHEN we consider the cost of electric motors as compared with that of the whole equipment for electrically driven cars, it is astonishing to find what indifferent attention is given to their maintenance on the part of the responsible operating officials of many electric railways. Where motor troubles are experienced, it will generally be found, upon investigation, that it arises through a lack of proper care and maintenance. It is perhaps not remarkable to also find that such officials are the ones who are inclined to criticise the work of the manufacturer who supplied the motors.

Of course, there are times when, through carelessness or oversight, apparatus is sent out from the works of the manufacturer in an unsatisfactory condition; yet manufacturers, as a rule, make a special effort to turn out this class of apparatus, which is always produced in large numbers, in thoroughly good condition. It is the purpose of this paper to direct attention to a number of features which should receive special attention from the operating staff of an electric railway.

The following remarks in general apply equally well to equipments of small capacity for city working, and of greater capacity for suburban, interurban, or railroad working; but in applying them to any particular equipments, due consideration should be given to the local conditions and special features of the case.

I consider it advisable to caution prospective purchasers from being over-confident and relying too much upon their own judgment in selecting equipments, as the manufacturers' engineers have undoubtedly had more general experience and are more familiar with the possibilities of the various equipments, and therefore qualified to exercise the better judgment, provided, of course, that they are supplied with the necessary detail information, such as profile of line, curvatures, schedule speed, weight of cars, trolley voltages, etc.

You will, no doubt, have frequently heard operating men say:—"Why go to the expense of purchasing spring or cradle suspensions for motors, when the rigid or nose suspension, so far as we can see, is equally good and less costly?" I call to mind an instance of two railways, the operating conditions being very similar, one of which adopted spring suspension for the motors and the other did not. After an extended period of operation, the cars on the one road ride easier than those on the other.

Figs. 1 and 2 show a method of suspending heavy motors, to be used for railway working, and Figs. 3 and 4 show methods of suspending small motors for tramway work; all three types have given very good results, and while the saving cannot be shown in dollars and cents yet it is granted, without qualification, by shrewd and experienced operators. Concerning the suspension shown in Figs. 1 and 2, I would say that I have had two years' experience with this on an electrified steam railway where the condition of the permanent way is far from good, and it is the opinion of the railway company's engineers that the wear and tear on the motors and trucks would have been serious had they not been relieved of the shock from the motors resulting from the condition of the track.

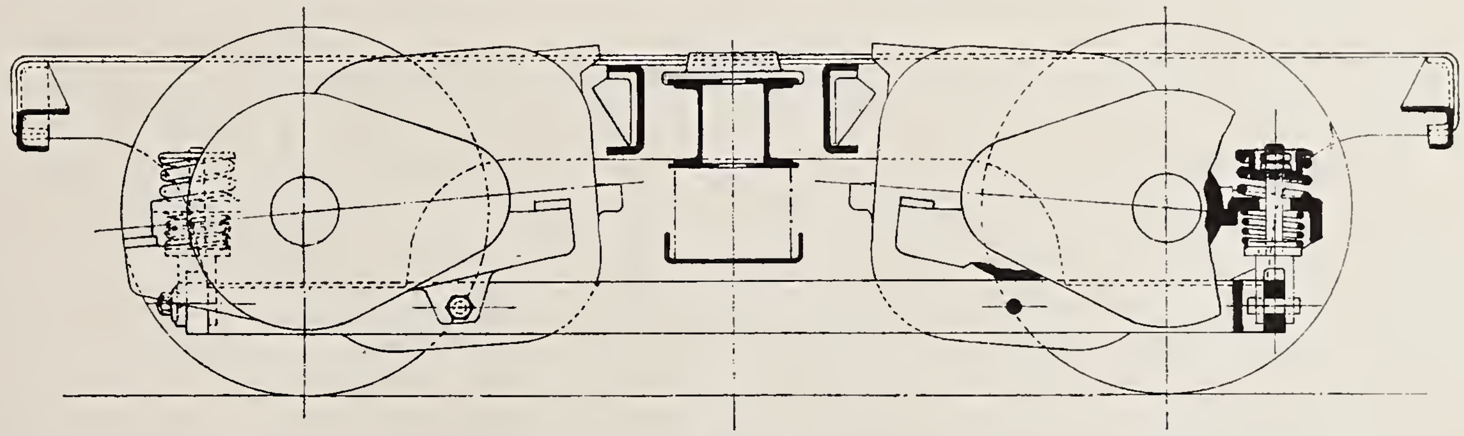


FIG. 1.—SIDE VIEW OF THE WESTINGHOUSE METHOD OF CRADLE SUSPENSION FOR HEAVY MOTORS ON THE METROPOLITAN RAILWAY, LONDON

INSTALLATION

The old adage, "The more haste the less speed," is never more strongly certified than when one sees a new motor taken from the storeroom and mounted upon a truck without having been opened and examination made to see that everything is in proper and efficient working order. To many this may ap-

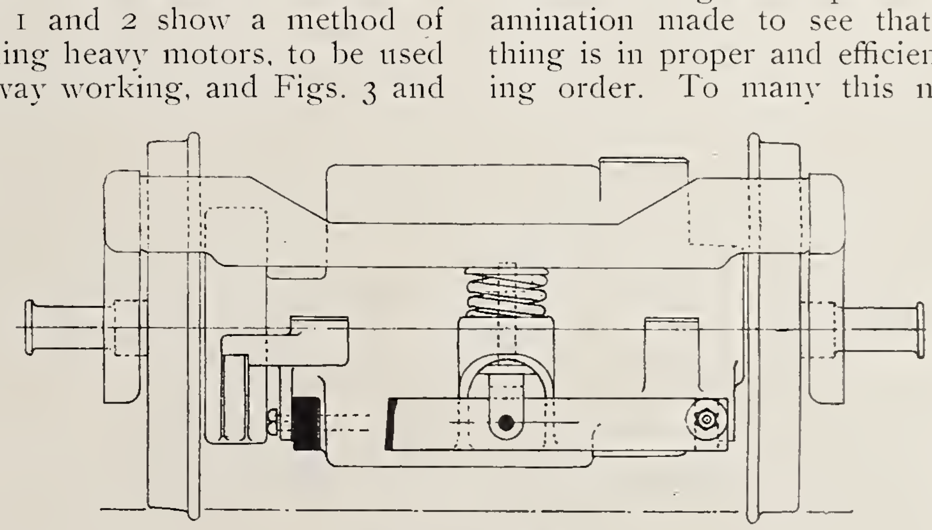
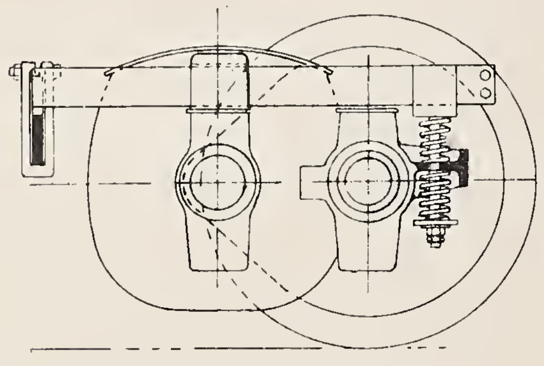


FIG. 2.—END VIEW

pear to incur an unwarranted expense, but if one stops to consider how small this is compared with the cost of new field coils, or rewinding of the armature, to say nothing of the commercial value, which cannot be estimated, of maintaining an uninterrupted service, I think you will agree that the expense results in an actual saving. This has been borne out by the experience and observations of the employees of both railway companies and manufacturing companies.



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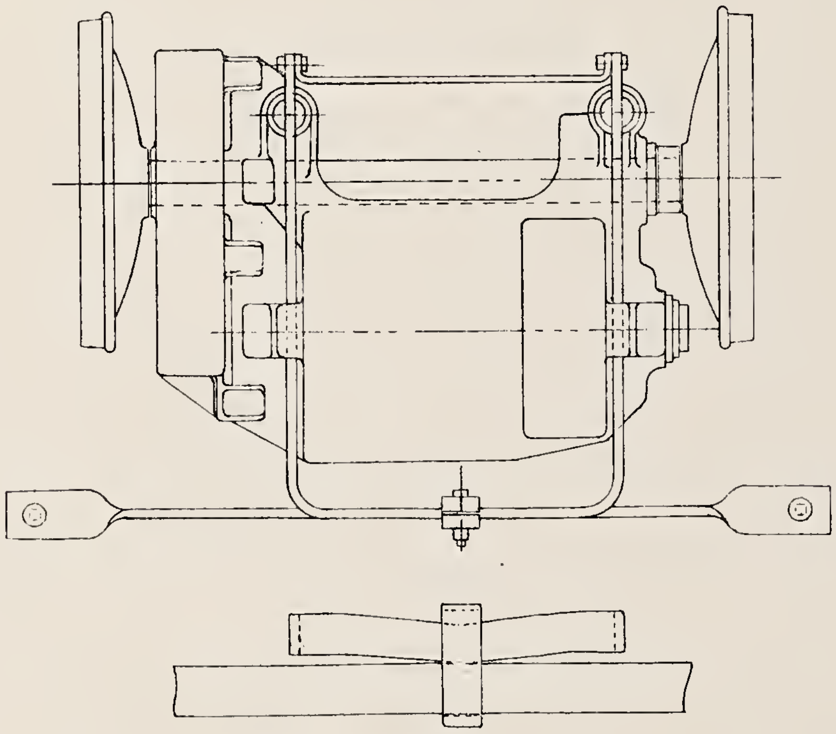


Plan and Front View of Cradle.

FIG. 3.—CRADLE SUSPENSICN FOR SMALL MOTORS FOR TRAMWAY WORK

In carrying out the above suggestions, the examination should be complete, giving attention to the field coils to see that these are firmly fixed in place without any danger of the insulation being chafed, and that they are properly connected. A case has come to my attention within the past few months where field coils were wrongly connected by a repair gang, and this car was, with others, made up into a train and sent onto the line. It had hardly gone into service before the motor in question began to flash, thus delaying the train and completely deranging the service of a congested metropolitan railway. Upon examining this motor, apparently nothing could be found, and the car was again sent into service with the same result. After this second occurrence the motor was opened, and upon investigation the wrongly connected coils were discovered.

In another instance the coils of an armature were in one case wrongly connected at the repair shops; and in the shop test, while the commutation was not so good as it should have been, yet the foreman said,—"Oh, it's good enough," with the result that after a few days' operation the motor burned out and caused delay to the traffic, to say nothing of the additional expense involved in jacking up the car and changing the armature. In many cases the result is not confined to the particular piece of apparatus, but may cause burning of the brush holders, commutator, and control parts.

Where the motors have removable pole pieces, it should be seen to that the bolts and nuts are properly tightened and fitted with lock washers. There, again, carelessness or indifference may result in serious damage. I have known cases where the pole pieces were not tightened, with the result that the nuts backed partially off and let the pole pieces down on to the armature, damaging both the armature and field coils.

Manufacturers invariably ship their motors with waste or wicks, according to the type of lubrication, in the bearing housings, and as this is used only for testing the motors in the shop, it should be removed and the oil wells thoroughly cleaned of sand and any other gritty material. The bearings should be fitted to their journals and the journals packed with good quality wool waste and the oil wells fitted with proper lubricating oil. With reference to armature bearings, I have obtained the best results with wool waste and a thick, filtered cylinder oil, as the thinner oil feeds so freely that it is difficult to keep it from getting into the motor and attacking the insulation. Care should be taken that the axle bearings fit properly into the fillets of the axle.

Care should also be taken that the pinions and gears properly mesh, that there is no undue friction through the teeth grinding on one another, and that full benefit is taken of the entire width of the tooth by having the gear and pinion accurately faced one to the other. In small equipments it is undoubtedly cheaper and equally as good to use split gears, but in larger equipments where space is limited, it is generally recognized that solid gears, properly keyed and pressed on against a shoulder of the axle with a pressure of 35 to 50 tons, according to the diameter of the axle, make a more mechanical job.

The alignment and spacing of the brush holders should receive attention, but this seems to be one of the things of which the importance is little understood. The brush holders should be adjusted so that the axis of the guides for the carbons will be radial to the commutator, and the centers of the carbons should span the proper number of commutator segments, depending upon the details of the motor. The brush holder should not be closer to the commutator than $\frac{3}{8}$ inch nor further away than $\frac{3}{4}$ inch. Should either of these limits be exceeded, the behaviour of of the carbons will be materially affected.

The question of proper carbons is one which, to my mind, does not receive the attention that its importance justifies. It is too frequently left to the discretion of the purchasing agent, who invariably orders the cheapest article without regard to performance, with the result that the men who look after the equipments have to worry along as best they can, frequently becoming so discouraged with the results that their inclination is to shirk this inspection, or else perform it half-heartedly. From my experience I strongly recommend choosing a carbon which gives good commutation, and then frequently boil this in a thin mineral oil, allowing it to remain in the oil from 12 to 24 hours, depending upon the size of the carbon, and allowing it to drip for 12 hours after removal. The oil should not be brought to a hard boil,

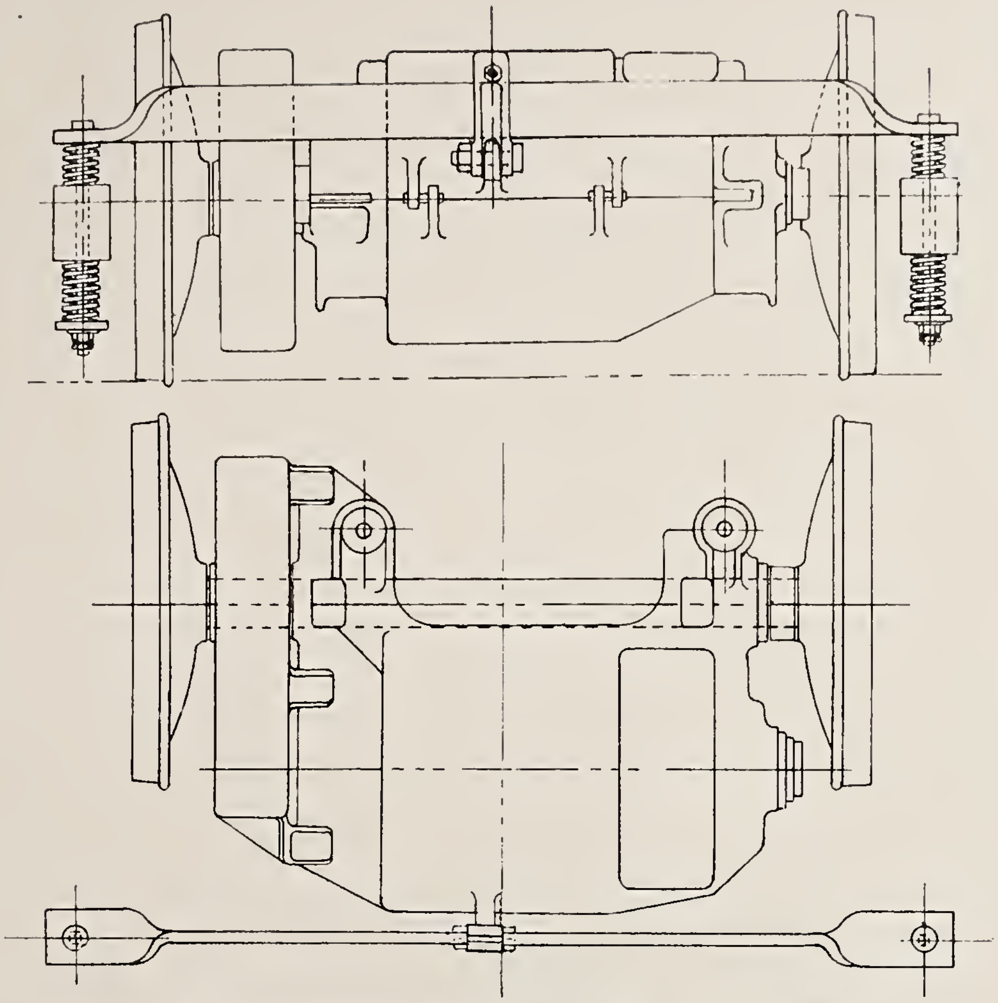


FIG. 4.—NOSE SUSPENSION FOR TRAMWAY MOTORS. PLAN AND FRONT VIEW

but simply allowed to simmer. The best results have been obtained by repeating this every sixth or seventh day, but I have found that the carbons will do very well when repeating this process every three weeks. Of course, there are many variations to this treatment, but on the whole the above will, in a general way, give good results.

The pressure with which the spring bears on the carbon materially affects the life of the carbon, and to a small extent the efficiency of the motor. The pressure of the springs should be sufficient to insure that the carbon will not "jump" at high speeds, but otherwise it should be as light as possible compatible with good commutation.

Before putting a new car into service I have found it best to give it some preliminary running to be sure that the bearings are all right and that the surface of the carbons and commutators is in good condition.

Frequently equipments are delivered and allowed to stand in wet places, and the insulation is not dried before the car goes into service. Then, as soon as the motors begin to warm, the insulation "sweats" and many breakdowns result. One instance recently came to my notice, where motor-car equipments of four 150-H. P. motors were stored for several months in an open shed in a very damp climate. When the time came to operate them, the insulation was in such a bad condition from this that it was necessary to place the cars over the inspection pits, open the motors, place fire-dogs under them, and keep these going for several days before it was considered safe to place the motors in operation. I recall another case which occurred several years ago, where the cars laid up at night, in both winter and summer, in an open shed on the border of a low-lying lake. Some of these cars would stand in this shed for several days and then be taken out and operated in a very hard service, with the result that the motor insulation repeatedly broke down. To overcome this the shed was tightly enclosed and the pits over which the cars stood were fitted with steam pipes. This entirely overcame the trouble.

MAINTENANCE

With equipments of large capacity it is unquestionably economical to have inspectors frequently examine each motor, wipe the dirt from the ends of the commutators and from the brush holders, and see that the carbons are not cracked, crumbled or chipped, and that they move with perfect freedom in the guides of the brush holders.

It is good practice to blow the dirt out of the motors with compressed air at least once a week. This method of removing the dirt is not perhaps the best, and I have been experimenting recently with vacua, but I have found it most difficult to devise a nozzle which will get into all the spaces, as the nozzle must be held close to the dirt which it is desired to remove.

The motors should be opened frequently and thoroughly cleaned and painted, and at least every six months the oil should be entirely removed from the oil wells and new oil supplied; the waste should be taken out and cleaned or else new waste supplied. The oil, of course, may be filtered, but there is a wide diversity of opinion as to whether it is economical to clean the waste; my own experience indicates that the waste loses quality by this process and that it is more economical to throw it away.

If the armature coils are open at the commutator and pinion ends, the dirt should be thoroughly cleaned from these spaces either by compressed air or vacua, and the armature thoroughly and carefully painted. Experience indicates that it is not so good to have these spaces open and that they should be completely enclosed by aprons. This is objected to by many, as it either increases the heating of the motor or else a greater section of copper must be used; but I consider that the benefit obtained in the operation outweighs the objections.

Better results will be obtained from the bearings if a very small quantity of oil (to be determined by experiment) be supplied to each of the bearings, if possible every night, a measure being used so that the inspector can supply just the right quantity. In this way it is always insured that the waste is properly saturated at the surface which is in contact with the journal, and it also insures that the oil well will not be filled to overflowing. It is a painful fact that nine out of every ten oilers fill an oil well until they see indications of its overflowing, without any regard to whether the bearing has been running for a day or a week without replenishing with oil.

Frequent inspection should be made with a gauge to see that the armature bearings have not worn sufficiently to let the armature get dangerously close to the lower pole pieces. A well designed bearing should wear from nine months to a year with the train making from 100 to 150 miles per day, and, therefore, from the records it should be quite easy to determine roughly when any particular motor needs examination. Mechanically, I think the armature may be allowed to get as close as 1-16-inch to the lower pole piece, but this cannot be taken as a hard-and-

fast rule, as the total air gap will influence it, since the voltage distribution will be altered when the armature gets considerably out of center.

The Temperature of the Electrodes During Electrolysis

THOUGH it is generally understood, says "Engineering," that the temperature exercises a considerable influence on all electrolytic processes, inasmuch as it affects the solubility of the materials, as well as the conductivity, viscosity and other properties of the solution, it seems often to be overlooked that the temperature of the electrolyte need not be the temperature of the electrodes on and near which the reactions really take place. But certain products are formed or are stable only within a limited range of temperature, and in this respect the temperature of the electrodes is the deciding factor.

Moldenhauer has studied the temperature differences between the electrode and the electrolyte under varying conditions of the electrolysis. He made use in these researches of tubular platinum electrodes, filled with mercury, into which a mercury thermometer was dipped.

As potential, current density, temperature, ionization, etc., are all inter-related, the results cannot be summed up in a few lines; much depends, of course, on the condition of the surface of the electrodes. But considerable differences of temperature were observed, and the study of sulphuric acid, phosphoric acid, hydrochloric acid, caustic potash, potassium carbonate, potassium chloride and other electrolytes gave, on the whole, regular curves. In the case of potassium chloride the temperature differences between anode and electrolyte are, when the current and the temperature of the electrolyte are kept constant, at first small, but they become larger, and show, in the presence of some caustic potash, a rhythmical fluctuation of more than 1 degree C.

Moldenhauer finally tried the effect of cooling the electrodes, especially the anodes. The electrodes were cooled by water circulation. When the anode was cooled to 11 degrees C. in a diluted sulphuric acid, kept at 12 degrees C., the yield of persulphuric acid was as high as could otherwise be obtained by cooling the whole cell down to — 4 degrees C. In a more concentrated sulphuric acid, the effect of cooling the anode was less marked, however. For the preparation of percarbonic acid, anode cooling proved decidedly advantageous. When potassium chloride was electrolyzed, the best current speed was secured by keeping the anode at 15 degrees C., and by varying the temperature of the anode, the ratio of hypochlorite to chlorate formed could be altered.

Moldenhauer's experiments, though only published recently, were made a few years ago, and it is to be hoped that they will be continued. We know from the researches of Hutton and others that the electrodes of electric furnaces can be preserved to a remarkable degree by cooling the electrodes in comparatively simple ways; and as most of the potassium chlorate is now made electrolytically, the suggestion appears to deserve attention.

Therapeutic Action of Incandescent Light

IN searching for a practicable means of applying light for general therapeutic purposes, various sources of radiant energy or light have been considered, says Robert M. Sterrett, M. D., in "The American Journal of Progressive Therapeutics." The use of the arc light for the production of the actinic rays is satisfactory, but the arc light alone does not give the other necessary rays. The idea was lately suggested of using the incandescent electric lamp of high candle-power.

The writer states that he has used incandescent lamps of 300 and 500 candle-power, and the good results in his limited experience have been widely corroborated by others of larger experience with lamps of similar candle-power.

The rays from these large incandescent lamps properly reflected and condensed are of dazzling whiteness, resembling pure sunlight. For this reason and because of their source, the writer has called them "leucodescent" rays. This form of lamp is truly a most faithful substitute for sunlight. The "leucodescent" rays include heat rays, luminous rays, and from their prompt inhibitory effect upon a number of pathogenic germs, undoubtedly include also actinic rays of sufficient power for germicidal effect.

These rays promptly overcome stasis, thus cutting short the inflammatory process. They do this by their dilating effect upon the vessels of the skin, which vessels are capable of holding more than one-half the entire circulation of the body. Thus inflammation of the various internal organs is relieved before serious results can take place, if the light is applied over the surface of the body in the inflamed region at an early stage of the difficulty.

Another very important quality of these rays is their power to promptly relieve pain,—not only temporarily, but for a considerable time subsequent to their application. Thus a great advantage is gained at the outset, in the treatment of rheumatism, neuralgia, colics, pleurisy, peritonitis, lumbago, hip-joint, and spinal diseases, ocomotor ataxia, etc. The promotion of resolution and the absorption of exudates are very marked when these white rays of high intensity are applied with vigour and persistency.

Whether it is the heat rays, the actinic rays, or all the rays that act with such success upon chronic ulcerating surfaces, is not known.

It is not contended here that the heat rays in the intensified white light are not of importance; they certainly are of importance. But the application of even a high degree of dry heat alone does not accomplish what is done by the "leucodescent" rays,—the full white light of the large incandescent lamp. These rays are, as in the case of pure sunlight, stimulating the nutrition,—are food to nerve cells. They increase the number and quality of red blood cells, though it is doubtful if they affect the leucocytes.

To sum up in a brief manner, these rays relieve pain, remove stasis, promote absorption, and are also decidedly germicidal. The simplicity with which they may be applied, the absence of any danger from "burns," in the sense of the X-ray dermatitis, and the wide field in which they are applicable makes them of practical utility in the routine work of the general practitioner, and well worthy of candid serious investigation.

Opening of the Carnegie Technical Schools

THE first of the initial group of seven structures that form the new Carnegie Technical Schools, at Pittsburg, was opened on October 16, with a class of 120 students, selected from more than 600 applicants from all parts of the world.

Schools for apprentices and journeymen are to be opened this month, and the forge shops, pattern shops, machine shops, foundry and other mechanical departments are being pushed to early completion.

Arthur Hamerschlag, formerly of New York, is director of the schools, which when completed will represent an outlay of more than $5,000,000.

The Electrification of the Long Island Railroad

By W. M. PROBASCO

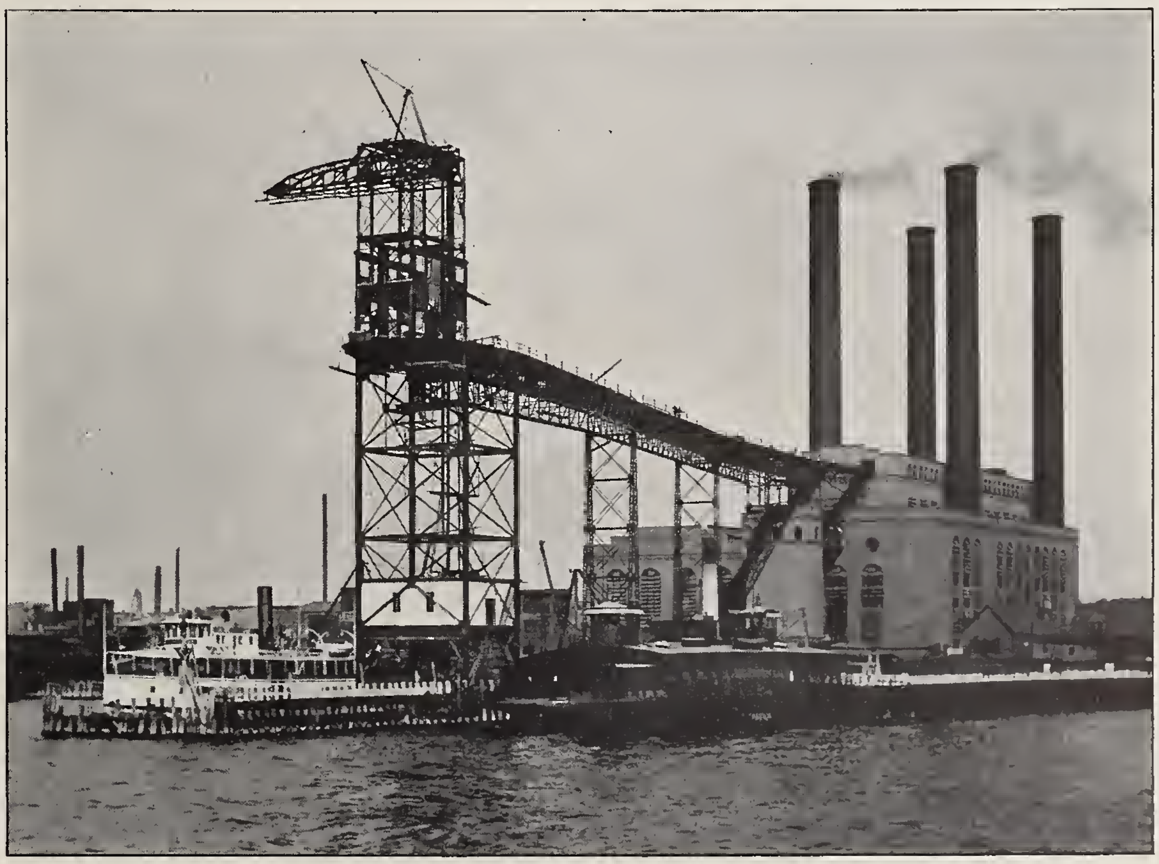
A TRAIN OF NINE STEEL CARS

THE western division of the Long Island Railroad consists of numerous lines within the limits of the city of New York, and while the main terminus of the road is in Long Island City, opposite Thirty-fourth street in the borough of Manhattan, the road has another very important terminus at the intersection of Atlantic and Flatbush avenues in the borough of Brooklyn. The line to the latter terminus is four-tracked from Jamaica to East New York, thence double-tracked through Atlantic avenue to Flatbush avenue. It originally traversed open farming country, but the enormous growth of the outlying districts in the borough of Brooklyn has resulted in the building up almost solidly of the section traversed by the railway line from Flatbush avenue out to East New York, and even beyond as far as Atkins avenue,—a distance of 5¼ miles.

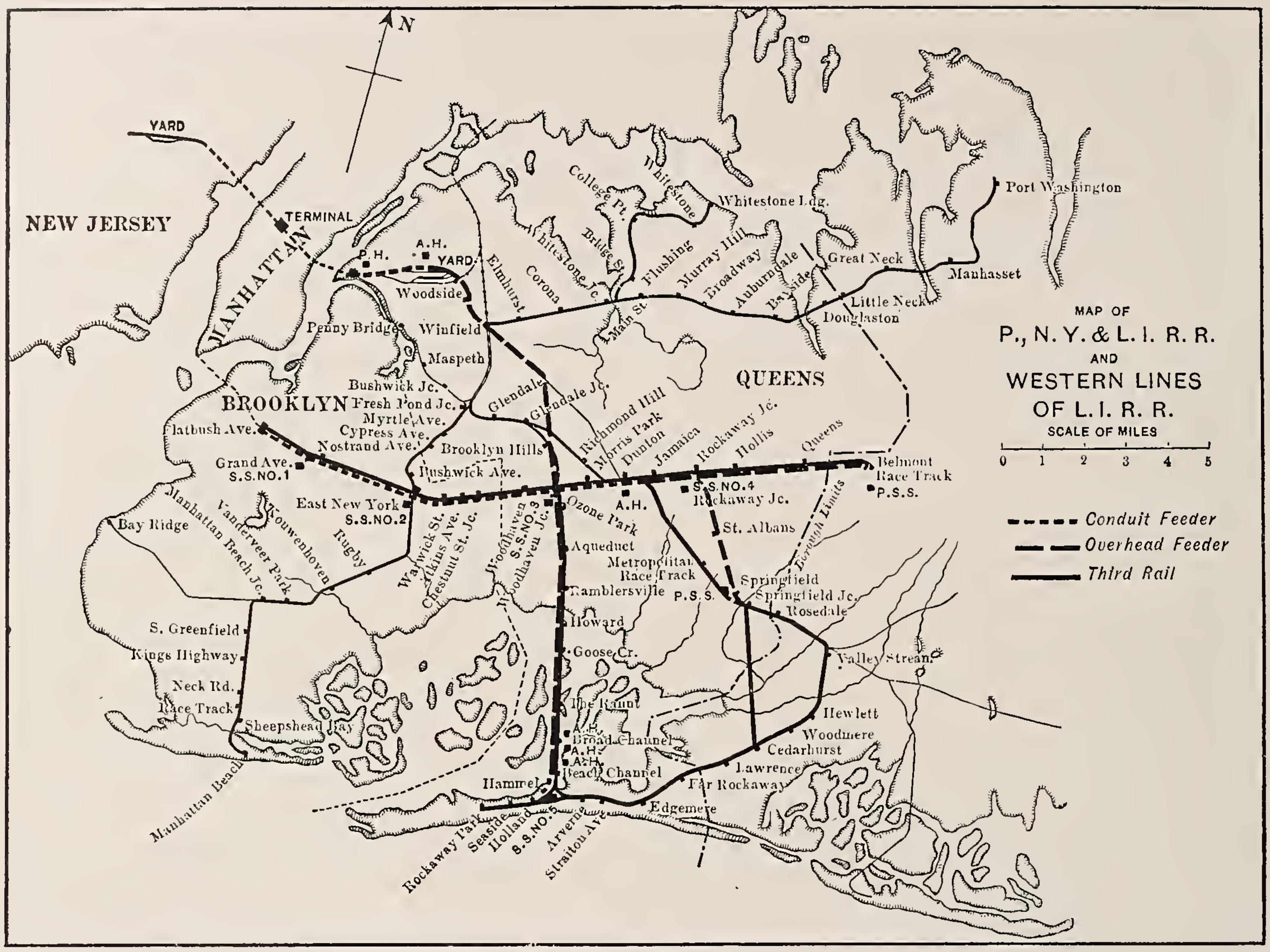
On agreement with the city, dated May 18, 1897, the railway company undertook to remove its tracks from the surface of Atlantic avenue, and to operate passenger trains on the line by a motive power not requiring combustion. This requirement obviously pointed to electric traction, and the planning of a satisfactory train service in this short section has resulted in the installation of the most extensive system of electrification yet put in operation on any steam railway in the world.

NATURE OF TRAFFIC

As before stated, the Long Island Railroad at the extreme west end of the island consists of a network of lines having two important city terminals, and conducting a heavy through, as well as a local, service. By reference to the map, it will be seen that the Flatbush terminal is in the heart of the borough of Brooklyn, and connects at that point with the Brooklyn Rapid Transit elevated lines leading to the Brooklyn Bridge and to the Broadway Ferry. It will also soon connect with the subway and tunnels being constructed by the



THE LONG ISLAND CITY POWER HOUSE IS EQUIPPED WITH STEAM TURBINES AND EVENTUALLY WILL BE ONE OF THE LARGEST IN THE WORLD



MAP OF THE ELECTRIFIED PORTION OF THE LONG ISLAND RAILROAD SYSTEM

Interborough Rapid Transit Company from the Battery, in the borough of Manhattan, under the East River, and thence to Flatbush and Atlantic avenues.

It will be seen that upon completion of the subway tunnel, passengers arriving at the Flatbush avenue terminal, from points on Long Island, will have a short and direct route to the lower business section of Manhattan Island, by either the subway or by the elevated lines over the Brooklyn Bridge. Furthermore, direct connection will be established by the elevated lines over the new Williamsburg Bridge.

The regular service on the Atlantic avenue line consists not only of suburban trains carrying passengers from towns on the south and north shores of the island, but also quite heavy local business from Flatbush avenue out to Jamaica, and very heavy excursion business to Rockaway Beach and three different race tracks, located at Aqueduct, Metropolitan, and Belmont Park, respectively.

THE TRANSMISSION LINE BETWEEN LONG ISLAND CITY AND WOODHAVEN JUNCTION

EXTENT OF ELECTRIFICATION

Considering the complicated train service previously referred to, it was obviously impossible to adopt an electrification plan which required electric haulage for part of the journey and steam haulage for the remainder of the journey to the principal points, beaches, and race tracks, inasmuch as transfer of passengers en route to these points would occasion endless confusion and delay. It was therefore determined, in spite of the fact that immediate return on the very heavy outlay could not be expected, to electrify all lines leading out of the Flatbush avenue terminal upon which heavy suburban or excursion business took place. This resulted practically in the electrification of the entire road south of Atlantic avenue and the main line out to Queens, and as far east on the Montauk division as Valley Stream. It was not found necessary to elec-

A STEEL MOTOR CAR, SHOWING CONTACT-SHOE PROTECTION

trify the line north of this dividing line, as no through traffic from Flatbush avenue to the terminal in Long Island City at present exists.

When the tunnel lines to the borough of Manhattan, now being constructed by the Pennsylvania Railroad Company, are completed, a new set of conditions will be introduced which will require very considerable extension of the electric service, and will no doubt include at that time all the lines of the company for, say, 25 miles out of both terminals.

An inspection of the map accompanying this article will illustrate the present system of electrification and its relation to the complete system.

The diverse character of the train service, and its very fluctuating loads at different seasons of the year, due to excursion business, formed an unfavourable condition for economical electric traction, owing to the low load factor throughout the year on any of the fixed portions of the complete system, as power house and transmission lines.

In spite of this very great handicap, which meant an enormously heavy initial expenditure, the management of the railroad determined to provide complete electric service at the outset, having faith that the improved facilities afforded would result in the growth of the territory adjacent to their line, and in the end afford them a fair return on their investment. It must be confessed, however, that for the present, and probably for some time to come, the expensive pioneering done by the company will result chiefly in increased convenience to their patrons rather than in enlarged net revenues.

Under normal conditions, the loading of the power plant and sub-stations will be comparatively light, but in order to take care of the heavy race track and excursion traffic, a power capacity has been installed sufficient to move simultaneously the following service:—

Fifteen 6-car trains per hour in each direction between Flatbush avenue and Belmont Park; three 6-car trains per hour in each direction between Flatbush avenue and Rockaway Park; and two 4-car trains per hour in each direction between Valley Stream and Hammel. In addition to these, power is supplied for the trolley car service between Rockaway Park and Jamaica.

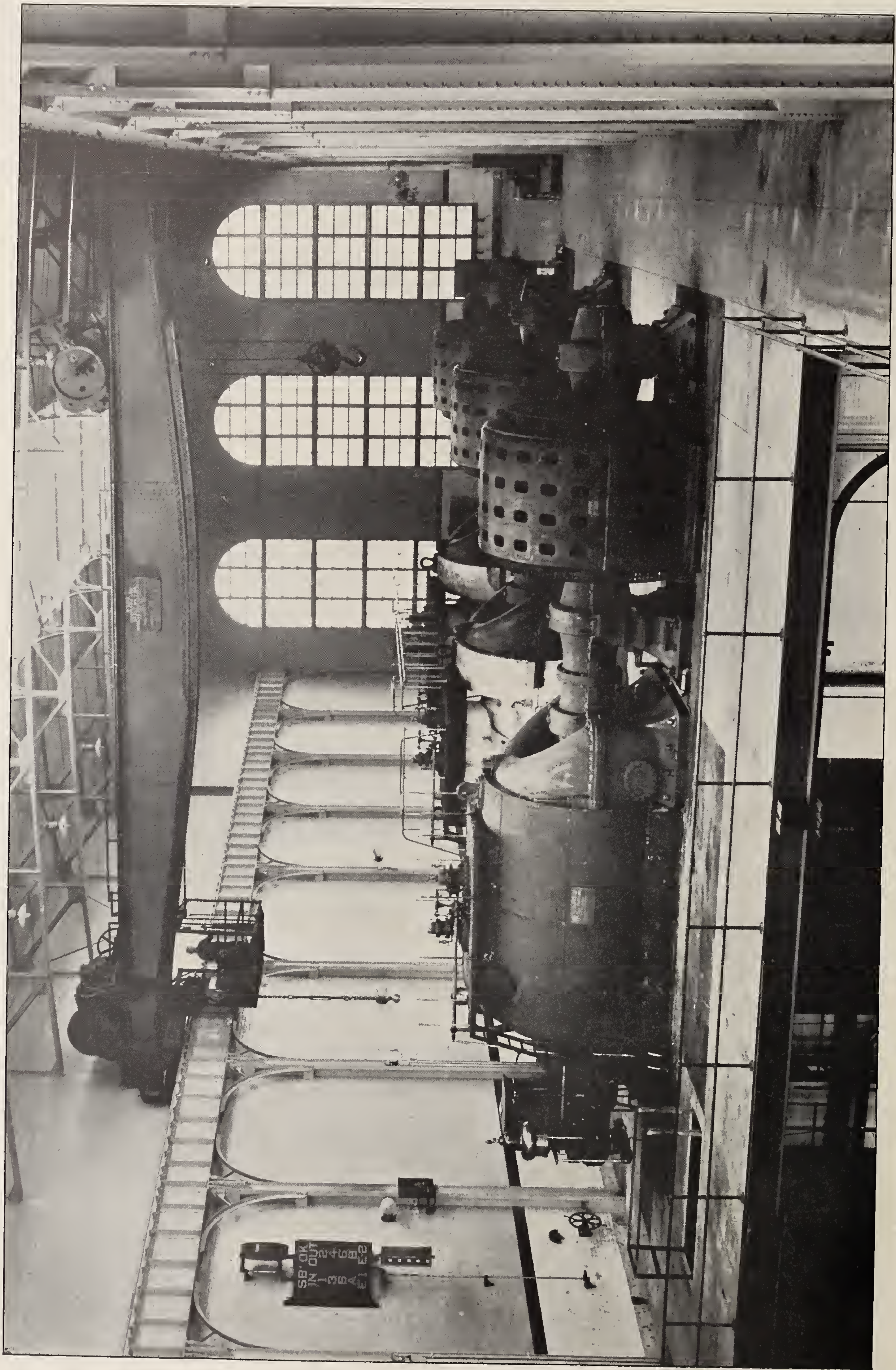
THE SYSTEM ADOPTED

A decision upon the character of the equipment and the characteristics of the electrical apparatus involved reference to the possibilities of connecting with the lines of neighbouring companies, including the Brooklyn Rapid Transit Company, the Interborough Rapid Transit Company and the Pennsylvania Railroad tunnels, as well as the physical character of the lines of the Long Island Railroad itself. In coming to a decision upon the work, therefore, operation over elevated lines, in subways, on the surface, and also in the Pennsylvania Railroad terminal and tunnels, had to be harmonized. It was decided, therefore, to adopt for the car equipment a type and dimension of car which would permit, if necessary, of through operation over connecting lines. It was also decided to adopt a system of electric distribution which was standard on connecting lines,—namely, third-rail contact and direct current at 600 volts for the propulsion current, and alternating-current transmission at 11,000 volts for conversion at substations.

THE GENERAL LAYOUT

Current for the entire system will be generated at the large power house now nearly completed at Long Island City. This power house will eventually be one of the largest in the world, and has the distinction of being entirely equipped with steam turbines. There are at present installed three Westinghouse-Parsons turbine units, of 5500-KW. capacity each, and the engine room provides facilities for three more such units.

It will be noticed that this power



THE ENGINE ROOM IN THE LONG ISLAND CITY POWER HOUSE. THERE ARE THREE WESTINGHOUSE-PARSONS STEAM TURBINE GENERATORS, EACH OF 5500-KW. CAPACITY

house does not stand at the center of gravity of the electrified system at present, but it must be remembered that the Long Island electrification forms a part of the general scheme for the operation of the Pennsylvania Railroad terminal and the moving of trains in the North and East River tunnels. When all these improvements are in complete operation, and when the western division of the Long Island Railroad is entirely electrified, the Long Island City location will be about in the center of distribution.

The three-phase alternating current, generated at the power house, is carried in conduits through the built-up portion of Long Island City as far as the railroad yards. From here the cables are brought overhead and carried on a specially designed lattice steel pole line. The construction of this pole line is most interesting, and represents an advance over anything hitherto attempted in this direction. The poles are of very strong construction and are mounted on concrete foundations. Wherever the transmission lines cross telegraph or telephone wires, the latter are led underneath the high-tension wires, the very substantial character of the heavy electric cables precluding their breaking and falling across the telegraph wires. A further precaution is taken by having the poles placed closer together at such points.

This pole line follows the railroad tracks to Winfield, from which place it is led across country on a special right of way to Glendale Junction, where it again follows the railroad to the sub-station at Woodhaven Junction. At this point the lines branch off in the direction of the different sub-stations.

In a transmission line of this kind where bare wires are used, there is always a certain amount of danger to be feared from the effects of lightning. This has been very carefully guarded against in the present installation, as lightning arresters have been placed in all sub-stations, and special arrester and cut-out houses have been erected at all places where the transmission wires are led from overhead and carried in underground or submarine conduits, and vice versa.

The sub-stations are five in number and are located at the following places:—Grand and Atlantic avenues, Brooklyn; East New York; Woodhaven Junction; near Rockaway Junction; and Hammel.

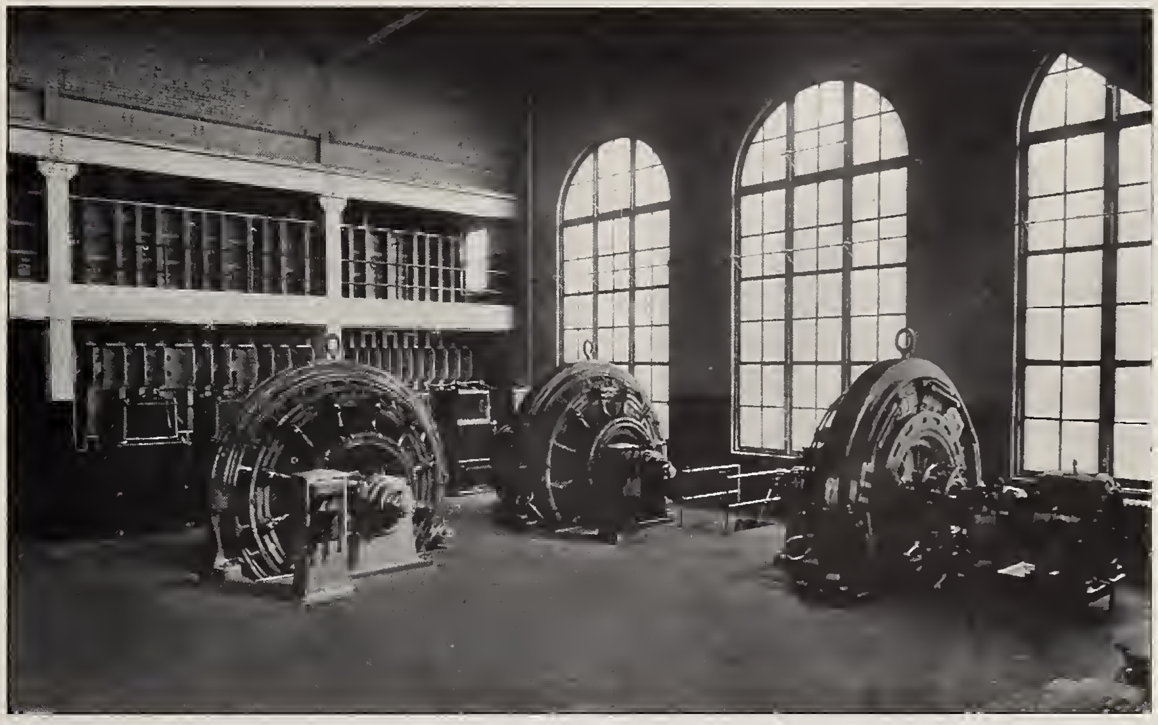
It will be noticed that as far as possible sub-stations were located at the junction points, these places being more practicable for the sub-stations, as they are the points at which the heavy loads occur. Such locations also make it possible and convenient for the arrangement of transfer switches on the high-tension circuit.

Taking up now the equipment of the different sub-stations, the one at Woohaven Junction is the largest of all, being provided with an initial equipment of three 1500-KW. rotary converters and nine static transformers of 550-KW. capacity. Ultimately, this station will be equipped with six 1500-KW. rotary converters, with a corresponding increase in the number of static transformers.

The Grand avenue sub-station is provided with an initial equipment of three 1000-KW. rotary converters and nine static transformers of 375-KW. capacity. The ultimate capacity, however, will include four 1500-KW. rotary converters, with a corresponding increase in transformer capacity.

It may be said here that all these sub-stations, which are now equipped with 1000-KW. rotary converters, are provided with foundations of sufficient size to accommodate converters of 1500-KW. capacity. The idea is that, as soon as the present sub-stations reach their maximum capacity with 1000-KW. converters, the sections of railway, electrically equipped, will have extended far enough to warrant the building of more sub-stations further out on Long Island. It will, therefore, be possible to move the 1000-KW. converters from their present stations to

THE EAST NEW YORK SUB-STATION



INTERIOR OF THE STATION, SHOWING THE ROTARY CONVERTERS AND THE HIGH-TENSION SWITCHING GALLERIES

THIRD-RAIL CONSTRUCTION AT A HIGHWAY CROSSING NEAR WOODHAVEN JUNCTION

the outlying ones and erect in their place converters of 1500-KW. capacity.

The Rockaway Junction sub-station is provided at present with an initial equipment of two 1000-KW. rotary converters and six static transformers of 375-KW. capacity. The ultimate equipment will include four 1500-KW. rotary converters and the proper number of static transformers.

The East New York sub-station has an equipment of three 1000-KW. rotary converters with nine 375-KW. transformers, while the ultimate equipment will consist of four 1500-KW. rotary converters and the corresponding number of transformers.

The sub-station at Hammel is equipped with two 1000-KW. rotary converters and six 375-KW. transformers. Ultimately, however, it will contain six 1500-KW. rotary converters, with a corresponding increase in transformer capacity. In addition, this sub-station is provided with a storage battery of 2000-kilowatt-hours capacity, making it the largest storage-battery plant in the world in use for electric railway work.

The battery installation was deemed expedient owing to the fact that the Hammel sub-station is the furthest from the power station and the transmission line is exposed to an unusual extent, being carried 4 miles over Jamaica Bay. Furthermore, the load at Hammel is very light during the winter, and the very large battery capacity makes it practicable to shut down the rotary equipment for much of the time during the winter months.

In external appearance, all these sub-stations very much resemble each other, being built of brick and steel, and of fireproof construction throughout. They also conform closely in interior arrangement, the rotaries and transformers being set up on the first floor, while the main switchboard is placed in a gallery on one side of the building, from which the operators have an uninterrupted view of all the machinery under their control. The high-tension cables are led to a carefully insulated board on the other side of the building facing the main switchboard.

Before leaving the subject of sub-stations, it might be well to mention that all of them are provided, on emergency, with the means of augmenting their capacity to the extent of 1000 KW. through the use of portable sub-stations. These consist of steel cars, each carrying a 1000-KW. rotary converter and three static transformers. Two such portable sub-stations have been built. They were designed primarily, not only to reinforce the permanent sub-stations, but to maintain the potential at any points where traction might, temporarily, be very heavy. Such conditions would be met at the different race tracks, and therefore buildings have been provided at Belmont Park race track and at Springfield Junction, near the Metropolitan race track, where these portable sub-stations may be housed and connected up.

While the use of portable sub-stations is not new, yet it is interesting to know that their installation here is on a larger scale than has ever before been attempted. One reason for their extensive employment is that no feeders are used for supplying the third rail, the high conductivity of these rails permitting of the dispensing of feeders for all ordinary conditions of traffic.

THE THIRD RAIL

Direct current, at a potential of 600 volts, is led directly to the third rail from the different sub-stations, and is carried in this way to considerable distances, great care being taken and much money spent with

this third-rail installation to guarantee the safety of pedestrians.

The third rail is laid at the standard distance from the track rail adopted by this road, the Pennsylvania Railroad and the Interborough Rapid Transit Company, namely, 27 inches from the gauge line of the track to the center line of the third rail, and with top of rail $3\frac{1}{2}$ inches above the top of the track rail. Placing the third rail in this position will allow of interchange between the railroads mentioned, and will permit of proper clearances for steam equipment, especially the steel hopper cars now in general use.

The rail is laid on sleepers which extend at intervals beyond the line of track, and is supported by insulators made of vitrified clay. It is covered throughout its entire length by a wooden sheathing held in place in the following manner. Brackets of steel attached to the rail are firmly bolted to wooden uprights outside the rail, and to these, by separate bolts, is attached a second set of strong brackets supporting a plank 2 inches thick and at a height of about 4 inches above the rail.

Wherever the third rail is led in front of stations, a special sheathing is attached to both sides, making it practically impossible for pedestrians to come in contact with it. Another feature in connection with the protection of passengers at stations is a running board, similar to the one covering the third rail, which is led along the outside edge of the platform, effectually preventing passengers from coming in contact with the collector shoes of the motor cars.

A STEEL-CONCRETE BUILDING AT BELMONT PARK FOR HOUSING TWO PORTABLE SUB-STATIONS

At either side of a grade crossing, the third rail terminates in a broad sloping shoe, similar to that at switches and crossings in the subway or on the elevated lines in New York. This is considerably within the line of protecting fences which enclose the entire right of way, and a heavy insulated wire cable connects it with the third rail, similarly situated beyond the break. The cable passes underground in a concrete duct situated at a depth not likely to permit of interference by crossing repairs.

The total mileage of third-rail installation reduced to a single-track basis is $97\frac{1}{2}$. This is divided up in the following manner:—Main line single track, 90 miles; sidings, 7.5 miles.

TRAINS

The trains are made up of steel motor cars. One hundred and

THE TWO PORTABLE SUB-STATIONS AT BELMONT PARK

THE TERMINAL FOR ELECTRIC TRAINS AT BELMONT PARK

thirty cars of this type have already been equipped, and trailers in the ratio of three to two; that is, a five-car train will consist of three motor cars and two trail cars, the motor cars being cars 1, 3, and 5. An eight-car train, however, will consist of five motor cars and three trail cars, the motor cars being 1, 3, 5, 6, and 8, or else 1, 3, 4, 6, and 8. By this arrangement, it is possible to make up three-car trains consisting of two motor cars with a trail car between them, by simply taking off two cars from either end of a five-car train.

All the cars are equipped with the Westinghouse pneumatic multiple-unit system of control, and each motor car has two propelling motors of 200-H. P. each, both of which are carried on the same truck; that is, each motor car has a motor truck at one end carrying two motors, one geared to each axle, while the truck at the other end of the car is a "trailer" and carries no motive power. Both cars and trucks were designed by George Gibbs, chief engineer of electric traction for the Pennsylvania, New York & Long Island Railroad, and for the Long Island Railroad, and were built by the American Car Company, of St. Louis, Mo., and the Baldwin Locomotive Works, of Philadelphia, Pa., the cars being built by the former company and the trucks by the latter.

These cars are quite similar in appearance to the steel cars in use on the New York Subway (which were also designed by Mr. Gibbs), being constructed throughout of steel and finished in aluminium. The problem of their design was considerably simplified through the experience already gained with the subway cars. The requirements of the Long Island Railroad, however, necessitated the embodying of a good many special features in order to conform to the requirements of the service. For instance, all the conditions and limitations which applied to the New York Subway, such as limited subway heights and clearances on curves, high speeds with frequent stops, maximum strength combined with smallest possible weight, etc., applied with equal force to the Long Island problem, since the Long Island cars were designed to interchange with the cars in the New York Subway. An additional feature presented itself, however, in the fact that trains, after leaving the city limits, had to run on the ground and let passengers on or off at stations whose platform did not come flush with the platforms of the cars. This necessitated the design of a special combination platform which would provide for a pair of steps to be used when running on the surface of the ground.

These cars are now receiving their equipment at the shops of the Long Island Railroad between Locust avenue and Springfield, on the cut-off line to Valley Stream. The shops have a capacity for the equipment of about ten cars per week, which number of cars are received from the builders in an entirely completed condition as regards exterior and interior finish, but are bare of any electrical apparatus. After receiving their electrical equipment they are given many trial runs before being placed in active service.

Each motor car weighs 83,000 pounds, and is capable of maintaining a maximum speed of 55 miles per hour and a schedule speed, including stops 1.6 miles apart, of 25 miles per hour.

A noticeable feature of their operation is the fact that, although the cars attain their maximum speed under very short headway, there is no jerk or jar experienced in the process, acceleration being accomplished very smoothly and evenly. The trains are brought to a stop in the same even manner, being equipped with specially designed air brakes controlled by the new Westinghouse graduated release triple valve. In this respect the equipment is a great improvement over any electric trains hitherto tried.

INSPECTION SHEDS

In order that the rolling stock of the road be kept to its full efficiency, large car inspection sheds have been erected at Rockaway Park, Dunton, and at the Morris Park shops. The shed at Rockaway Park is 100 by 30 feet in size, the Dunton shed 200 by 50 feet, and the shed at Morris Park is 200 by 75 feet. These sheds are large enough to accommodate trains of eight cars, and are fitted with all necessary tools and appliances, the pits being fitted with compressed air pipes in order that pneumatic tools may be used under the cars.

ORGANIZATION

When it was decided, three years ago, to electrify the system, Messrs. Westinghouse, Church, Kerr & Co., of New York, were engaged to act as engineers and constructors for the road, the entire work being under the direction of George Gibbs, who acted first as electrical engineer of the road and first vice-president of Westinghouse, Church, Kerr & Co., and afterwards as chief engineer of electric traction for the road. The general features of the work were under the supervision of the electrical committee of the road, composed of various officials.

The construction work was under the supervision of George B. Caldwell, who acted as superintendent of that department.

Work was begun on the power house September 15, 1903; the first engine was put in operation January 6, 1905, and regular operation begun July 26, 1905. Work on the sub-stations was begun May 24, 1904, completed July 7, 1905, and the sub-stations put into operation July 26, 1905. The transmission system was started November 30, 1904, and finished May 27, 1905, while work on the third rail and the bonding of the tracks was begun October 6, 1904, finished August 31, 1905, and put into operation July 26, 1905.

Electrical Engineering at Niagara

Reminiscences

By PAUL M. LINCOLN

Mr. Lincoln joined the forces of the Niagara Falls Power Company in February, 1895, to look after the company's electrical installations which began to supply current commercially a little later in that year. His work at Niagara Falls continued for the next seven years,—until May, 1902,—when he again resumed his earlier connection with the Westinghouse Electric & Manufacturing Company at Pittsburg

IN any other profession than engineering and in any other branch of engineering than electrical it would be presumptuous to record reminiscences which are, as in this case, less than ten years old. The term, reminiscences, carries with it an idea of age,—of a lapse of time which under ordinary circumstances would not be attained within a period of ten years. Reminiscences, however, are not so much the product of the mere lapse of time as of the progress of events.

Development has taken place rapidly with the electrical engineer. Events have transpired within the last ten years that, were we looking forward at the result as one to be attained, instead of backward at the actual achievement, one might well be astounded that only ten years have elapsed.

Measured, therefore, by the progress of events, rather than by the lapse of time, the electric generators that began to deliver Niagara power in 1895 are at least grandfathers,—perhaps great-grandfathers. Generations of electric machinery have come and gone since the installation of the first Niagara machines. Under these circumstances, therefore, I feel justified in jotting down the few recollections that follow, because they are recollections of one of the earliest as well as one of the most important of all electrical developments.

Niagara marks an epoch in electrical engineering. It stands as a monument to the greatest single step in advance that was ever taken in the electrical field. At the time the Niagara machines were designed they were about four times the capacity of any previous alternators that had been successfully operated. That in itself was sufficient to make the plant a memorable one.

Many questions arose concerning that installation that had to be worked out on the ground,—things with which little or no previous experience had been gained. For instance, little was known at that time about parallel operation of alternating-current machinery. The question as to whether the large new generators would operate successfully in parallel was one that gave the engineers of the builders no little uneasiness.

How would the generators synchronize? Would they hunt after being synchronized? Could an unloaded machine be paralleled with loaded ones? These were a few of the questions that were asked and discussed, not so much because there was uncertainty as to the theoretical results as because there were untried elements in the problem.

The feeling about the matter of paralleling was such that it was decided finally to wait until three machines were available before making any attempts to synchronize,—one to carry the load and two on which to make experiments. This programme, however, was never carried out.

One day, shortly after first starting with commercial load and at a time when only the first two machines were available, a confused switchboard attendant made a mistake in throwing a switch, and the deed was done. It was thus purely by accident that these machines were paralleled for the first time, and the remarkable part of the performance was that the paralleling switch was closed so nearly the proper time that hardly a mark was distinguishable upon the points of first contact. After it was observed that the machines cut up no particular antics while operating on the same bus bars, our minds felt considerable relief on the score of parallel operation.

Immediately, however, another difficulty arose,—could the machines safely be taken out of parallel? Would the switching apparatus work successfully under these conditions? What would be the effect on the load? Rather than run any risks, it was decided not to use the generator switch to pull the machines apart in this case, but to postpone the use of that method of operating until after it had been tried experimentally. Our method of getting the machines out of parallel on this first occasion was, therefore, to open simultaneously the field circuit breakers of both machines. The machines were then pulled apart and the load started up again on one of them.

The problem of taking care of the discharge of the generator field had, of course, been thoroughly thrashed out before putting any load on the machines,—in fact, before the machines were even started. To my mind, this incident tells more forcibly than can any words the immense progress that electrical engineering has made since that day. To-day our action looks like an unnecessary fear of a trivial operation, when it was a just distrust of an untried problem. That such a state of mind was possible only ten years ago speaks volumes for the progress of the art.

In any plant the starting period is one of vicissitude. Niagara was no exception. The first difficulties encountered were with the bearing that kept the long vertical shaft properly lined up. It was during April, 1895, that the generators were turned by the water-wheels for the first time. It required some time to straighten out the difficulties with the bearings. Then came a period of test for the generators and water-wheels, so that it was not until August, 1895, that we were ready to begin commercial operations.

There is one incident connected with the starting of the first commercial plant that will bear repeating, for it emphasizes a moral. The plant of the Pittsburg Reduction Company, manufacturers of aluminium, was to be started first. This plant consisted of some large rotary converters whose function was to convert the alternating current received from the Niagara Power Com-

pany into the direct current necessary for use in the aluminium process.

So far as we could tell, everything was ready for starting at both the main and auxiliary plants on August 26, 1895. Much against the wishes of the engineers, no rehearsal start was permitted; the switches were to be thrown on August 26, and things were expected to start. The morning of the 26th came, and in the presence of quite a delegation of officers of the power company the switches were closed. Instead of starting as desired, however, the rotary converters stood still and simply rumbled. Investigation showed that by an error two of the cables coming from the power house half a mile away were interchanged so that the "phases" were crossed. It was an error that had no significance, but the company's officers who had assembled to see the start were much disappointed. After a few hours' work the trouble was found and remedied, and a new start was made without further difficulty. The moral is evident. Don't advertise to start a plant of this kind until sure that every one of the almost numberless details is ready to do its share of the work.

The problem of how to care for the visitors who came to see our power development was one that received considerable thought during the first year or two of operation. It was found impracticable to exclude them altogether for obvious reasons. On the other hand, for reasons of personal safety they could not be admitted freely to the plant without competent guides. The matter was finally disposed of by allowing visitors to see the plant on payment of a small fee, which secured for them the services of a guide. The proceeds were first applied to the expense of maintaining this system of guides, and the remainder was turned over to the local hospitals of Niagara Falls.

The ludicrous questions that were asked by the visitors would fill volumes. One man wanted to know what make of pump was used to pump the water from the wheel-pit. Another was surprised to see the water going into the penstocks leading to the turbines, instead of coming out. They both probably had some vague idea that we had to pump out the water after it had passed through the turbines. "Oh, then you don't use the falls; you just use the river as a source of water supply"; and, "Why can't we have a similar development at Detroit? We have as great a water supply as you have here." These are samples of the remarks that were continually being made.

Usually it was easy to convince these doubters that the falls were a necessary part of our development scheme, and that the idea of pumping the water out of the wheel-pit was equivalent to trying to lift one's self by one's own boot-straps.

Another man's question would be, "Where is your big wheel?" I have often felt that I would like to put myself into that man's place and see for myself the picture that he had made for himself of our plant. Probably he expected to see a huge breast-wheel set up against the falls themselves, and perhaps connected to machinery by belt, or chain, or gear.

Apropos of this suggestion, another man asked how we kept our big belt dry. Questioning developed that his idea of our development was that the power, obtained in some mysterious manner from the falls, was transmitted through the tunnel by belt to the electrical machinery in the power house. He had heard of our power plant for generating electricity, and of the tunnel as a part of the scheme. His imagination had supplied a belt connection through this tunnel, and the greatest difficulty he saw was the slipping of the belt on account of dampness.

On one occasion a party of visitors was being conducted through the plant just after a priming coat of red paint had been applied to some of the penstocks. The group was looking down into the wheel-pit, when one of the party exclaimed to an accompanying lady, evidently his wife,—"There, you can get some idea of the enormous energy developed. See, that big pipe has become red-hot with it." And it was said in a way to indicate that he was in earnest. The lady wondered that it was so cool in the pit in spite of the red-hot pipes.

On another occasion one of a large party of visitors kept up a continual running comment on all of the things he saw. He claimed to be from the Westinghouse shops in Pittsburg, and he told how he had made this part and designed that part. There seemed to be little about the whole plant in which he had not played a prominent role in its manufacture.

When the party was taken to the transformer room containing the Buffalo transmission transformers which had been made by the General Electric Company, he seemed to be somewhat nonplussed, and asked what they were. When explained, he remarked that he did not know so much about them, because they had been designed by a friend of his who had worked at the bench behind his.

One enthusiastic visitor exclaimed, as he looked down the line of ten whirling generators,—"And is it possible that these dynamos supply all the lights of Niagara Falls?" Another asked how many volts were generated in a day; another, on hearing some general explanation on the output of the plant, asked where the kilowatts were kept, and if he could have one to take away as a souvenir.

Still another wanted to see our collection of diamonds. Questioning developed that he had heard something about the early work of Acheson, who discovered carborundum while trying to make diamonds, and that we had a magnificent collection on exhibition. As usual, this visitor's ideas were considerably garbled, and he thought that most of our power was used in making diamonds.

Another man standing at the top of the wheel-pit saw some water spray thrown through a crack at the bottom. "Is that your liquid air escaping?" he asked. On several occasions I have opened the trap-door over a running wheel to show the chaos of water as it leaves the turbines, and have had to restrain members of the party from starting down the ladder into it. They evidently thought it was the next place to go and were not to be daunted by a little water.

Niagara is, and always has been, a mecca for the tourist. Not all of them are of the same stripe as indicated by the foregoing incidents. Distinguished men from all walks of life and of all nations were continually going and coming. Not a small part of the interest in being attached to such a plant was the opportunity thus afforded of meeting and talking to well-known men who visited the plant. One of the earliest distinguished visitors was Li Hung Chang, the Chinese statesman. Four Chinese bearers carried him about seated in his Sedan chair. He showed due Chinese politeness by asking numberless questions about the things he saw.

It was then that occurred the incident of the cane that was considerably advertised by the newspapers of the following morning. The space between the brick switchboard structure and the generators opposite it is somewhat limited,—perhaps 8 or 10 feet wide. The Sedan chair was borne through this passage, and its occupant was thus brought near enough to one of the generators to reach it with the cane he carried.

While passing he reached out with

the cane and made several jabs at the rapidly revolving generator. The extruding bolt heads caught the stick and wrenched it from his grasp. The place was full of reporters at the time and much was made of the incident,—much more than it deserved. Li Hung Chang's object in making the move was evidently to find out at first hand something of the nature of the objects he was seeing. No damage whatever was done either to the machine or the visitor.

Another famous Chinaman whose visit left a vivid recollection in my mind was Wu Ting-fang, formerly Chinese Minister to the United States. He also showed true Chinese politeness by asking many questions, questions, too, that showed a keen appreciation of what he saw. Nor did he restrict his questions simply to what he saw.

A prominent engineer from Buffalo was a member of the party and both he and I were kept busy furnishing facts and figures in reply to the rapid fire of questions. Finally Wu detected a discrepancy between certain items of information that we had given him on the same subject. Instead of asking which of us was correct or maintaining silence, his question was "Which of you two is the abler engineer?" Since we were sitting at the time one on either side of him the question was somewhat embarrassing.

Nikola Tesla visited the plant for the first time in January, 1897. One incident will always make me remember his visit. In his tour around the plant his eye caught a small motor used in starting a rotary converter. "What is that?" he asked. The machine indicated was a Tesla motor. Surely "it is a wise father that knows his own child."

In 1901 Thomas A. Edison came to the plant for the first time. During his tour of inspection he remarked that he "didn't know very much about alternating current" and then proceeded to ask a string of questions so worded as to make it quite impossible to believe his statement.

President McKinley visited the plant just an hour or two before he was shot. On leaving the power house he went directly to the train which took him to the Pan-American Exposition at Buffalo where he was the chief figure at the fatal reception in Music Hall. His last signature was written in the visitor's register which has always been kept at the power house.

Lord Kelvin visited the plant at least twice and always took a keen interest in its development. Prince Hilkoff, the Russian Minister of Railways, was another interested visitor. Prince Henry, of Prussia, made the inspection of the power plant a part of his tour of the United States. His official host was "Fighting Bob" Evans. Among others whose names occur to me are Theodore Roosevelt (while Governor of New York), Admiral Sampson, General Joe Wheeler, Andrew Carnegie, J. P. Morgan, and the Duke of Marlborough. These are only a small fraction of the names that could be given of men known to fame who have been attracted to Niagara by the double magnet of the world's greatest artificial wonder situated alongside of the world's greatest natural wonder.

I find that the impression is more or less prevalent that the Niagara Power plant has had more than its share of troubles. That there have been minor difficulties no one will deny, but that there have been more than might reasonably have been expected, taking into consideration the character of the plant and the magnitude of some of the problems encountered, is emphatically not the case.

The record of this plant for continuity of service both on the local and on the long-distance loads is such as to uphold this statement. The real criterion too of a plant's success, at least from an engineering standpoint, is this ability to give continuous service. Some accidents have happened, of course, but recovery from their effect has always been rapid. Then, too, an accident to the Niagara plant is always advertised widely on account of its prominence.

Another disadvantage in this respect is the fact that continuous service at the Niagara plant means service for every minute of the twenty-four hours of every day in the year. This condition is due to the peculiar demand of the industries at Niagara. Continuous service in the ordinary lighting plant means continuous service during the lighting hours only; that is, a lighting plant has to keep "tuned up" only during five or six hours of the day. Niagara has to keep "tuned up" every hour of the day. Similarly, a railway plant has a respite during the early morning hours,—a chance to tie up any loose ends that may have developed during the day. At Niagara the falling off during this period is a comparatively small percentage of its total load. In spite of these handicaps Niagara's record for continuity of service is one to be proud of.

In looking back over one's experiences in such a plant it is natural that the mishaps, the accidents, the mistakes, should be the things that catch the eye rather than the record for good performance. They are the high spots that one's memory naturally bumps against as it travels over the past. Therefore I hope that it will not be taken as a record of normal operation if I jot down a few of these high spots.

Short circuits are among the things that have to be expected from time to time in any electrical plant. Niagara was no exception. It was early noticed, however, that these short circuits were more violent and gave evidence of a greater amount of current in the short circuit than had been anticipated.

The first Niagara generators were designed with poor regulation. It was expected that this would have the effect of limiting to a large extent the current that would flow on short circuit. After a few had occurred, however, evidences were noted of currents far in excess of the perhaps double full-load current that might be expected. On several occasions cables were thrown from the brackets to the floor by the magnetic repulsion that would take place between the out-going and return cable at the instant of short circuit.

One such short circuit involved the whole length of the cables running to the Pittsburg Reduction Company's works. For a distance of about 2000 feet these cables were carried in a tunnel about 3 feet wide and 5 feet high, on either side of which were placed about four tiers of brackets, each bracket capable of carrying four cables. The distance between the inside ends of these brackets was approximately 2 feet. The four cables to the Pittsburg Reduction Company were 950,000 C. M., about an inch and one-half in diameter over all, and weighed, including lead covering, approximately five pounds per foot. They were carried on one of the above tiers of brackets.

A heavy short circuit occurred at the Pittsburg Reduction Company's end of these cables. After the short, the outside cable, throughout the whole 2000 feet of its length in the tunnel, was found on the next lower tier of brackets on the opposite side of the tunnel, and the job was almost as neatly done as if a gang of men had made it their special business. Incredible you say? But I can point out to you the men who were assigned the work of putting the cable back.

On another occasion a short, at a time when six machines were running in parallel, gave a repulsion on a section of the bus-bar so great as to leave it bent about 3 or 4 inches

out of its former straight line. At this point the bus-bar consisted of a solid copper rod, 1 inch in diameter, and the supports were only 5 feet apart. The bar of opposite polarity was 24 inches away. It would take a powerful blow from a heavy sledge hammer to produce the same result mechanically. The amount of current necessary to produce this repulsion under these conditions must have been somewhere between 100,000 and 200,000 amperes. If this were equally divided among the six generators running at the time, each would have to supply from twenty to forty times the normal full-load current.

Nor did all the repulsion effects occur on the outside circuits. The repulsion effect on the windings of the armature was even more severe than that on the circuits outside the armature and presented a far more difficult problem. The distortion of the armature windings due to the heavy repulsion effects was sufficient to cause considerable damage to the insulation. In these machines this effect of electromagnetic repulsion in armature windings became for the first time a factor to be reckoned with. To-day no designer thinks of laying out a large machine without carefully considering the matter of proper bracing in the armature winding.

In a large machine a considerable amount of energy exists as magnetic flux set up by the field. Under a condition of short circuit this energy is practically zero. At the instant of short circuit this stored magnetic energy tends to escape with the utmost rapidity, and it is this sudden escape of that energy that causes the enormous currents whose effects are above mentioned. After a short circuit is once fully established, the amount of current from the armature may be easily calculated from the machine constants; while being established, however, the amount of current is enormously greater than obtains in the stable condition.

It was in these Niagara machines that this effect became for the first time a noticeable factor. It was not a very difficult task in this case to devise a bracing that was ample to take care of the strains, but it merely shows one of the new problems that was raised by the Niagara plant.

Another effect astonishing by its magnitude is the tremendous heat that is liberated during short-circuit condition. On the occasion of the short circuit of six paralleled machines mentioned before, the reaction of the armatures back on the fields was so great as to trip all the field breakers, although they were set for more than double normal current. The duration of the short circuit was, therefore, very small,—probably not more than one second. Nevertheless, the heat was sufficient to scorch to some little depth the head of a wooden reel that stood about 10 feet away, set fire to a bunch of waste 12 feet distant, and blister paint 18 feet distant.

On another occasion a short that lasted only from five to ten seconds melted out sections of several million C. M. cables that lay close together, the sections being from 2 to 8 feet long. The energy that it is possible thus to turn loose in an extremely small space of time must be seen to be appreciated.

The first Buffalo transmission line was installed in 1896, and started operation in November of that year. At the time of its installation it was one of the longest lines in existence and contemplated the delivery of by far the largest amount of power. While this line has always been highly successful, the casual recollection that I have of its operation is naturally of the accidents that happened to it occasionally. I find, through questions, put to me occasionally, that there is a popular impression that some of the accidents to the Buffalo line were caused by cats, and some have actually gone so far as to ask for an explanation as to exactly "why the electricity in a cat's fur should be so antagonistic to that in a dynamo?"

There is a germ of truth in these cat stories in that two shut-downs of the Buffalo line were caused by those animals. There was a considerable number of rats in and about the plant and a few cats were kept for their benefit. One night a short circuit occurred on the Buffalo line for which no reason could be assigned until the body of one of these cats, burnt almost to a cinder, was found between one of the high-tension choke coil terminals and ground.

On another occasion a cat climbed one of the transmission poles, about 10 or 15 miles from the Niagara end, and in some manner got its body between two of the conductors, although they were at this point 24 inches apart. A short circuit resulted, causing a brief shut-down of the line. Signs of an arc on the transmission conductors and the cat's burned body on the ground underneath were in our minds sufficient evidence to convict the cat.

The newspaper men got hold of this last incident and the fame thereof spread abroad, evidently growing as it spread, for about six months later some friend sent me a clipping from an English paper published in Hong Kong, describing an accident to the Niagara transmission line due to a cat, which resulted in depriving the whole of Western New York of power for hours.

On the Niagara line, as has also been noted on almost all other lines, a defective insulator would occasionally set fire to the top of a pole, usually at the point where it was joined by the cross-arm. On one occasion this happened to one of our poles near a farmer's house. Upon seeing the burning pole, the farmer secured a small pail of water, climbed the pole and put out the fire. Just how he escaped being killed in the operation is more than I have ever been able to understand.

The right of way of the transmission line was entirely cleared of trees very soon after starting the line. During the progress of this work a peculiar accident happened. A rather crooked branch, free of small limbs, lay on the ground near where the woodmen were felling a tree. When the tree fell it struck one end of this crooked branch in such a manner as to throw it high into the air. Falling, the branch lodged among the transmission conductors and stayed there. Although the transmitting cables were of 350,000 C. M. (practically $\frac{3}{4}$ of an inch in diameter) in about ten seconds two of them burned entirely in two and fell to the ground. The branch in this case was somewhat green and, therefore, a sufficiently good conductor to keep the energy of the partial short circuit concentrated at the point of contact.

Arcs have formed on transmission conductors quite frequently, but unless there is something to concentrate their force they do no damage to the conductors. The above is the only instance I recall where the copper line was burned apart. On another occasion the 500,000 C. M. aluminium line burned in two just under the edge of a metal hood that protected it where it entered the transformer house. In this case it seems probable that a lightning discharge jumped across about 15 inches, the dynamo current followed, and the arc was directed by the overhanging metal hood to approximately the same spot until the cable parted. In this ability to withstand the action of arcs, it is well known that aluminium is inferior to copper. The above, however, is the only case to my knowledge where the aluminium line at Niagara parted due to an arc.

So far as I am aware, it was at Niagara that for the first time was noted the excessive rush of current that often takes place in a trans-

former when first thrown on a line. A rotary converter supplied by the General Electric Company was arranged to start from the direct-current end. In order to prevent the shunting effect of the transformers, it was arranged that the alternating-current brushes should be raised on starting and placed in contact with the collector rings again after full speed had been reached.

It was noted that sometimes, on putting down the brushes, signs of an excessive current were present, a flash at the point of contact, and burning of the ring and brushes. An ammeter was put in circuit, of ample capacity to read the magnetizing current of these transformers, and almost at the first trial its needle received so violent an impulse as to twist it around the end stop.

Further experiment showed that the first rush of current might, under some conditions, amount to many times the full load of the transformer. The phenomenon is due to the fact that a transformer, on being disconnected from the circuit, may still have a very high "magnetic set." The magnetic circuit being an entirely closed one, a slight residual magnetic force leaves a large residual magnetic flux. On being reconnected to the circuit, if the first impulse of current tends to cause a magnetic flux in the same direction as the residual, evidently the iron is forced far beyond the saturation point, and in consequence an excessively large momentary magnetizing current is taken.

This condition is one which corrects itself rapidly and entirely disappears after a few alternations. It is also a condition which does not appear every time the transformer is connected to the line, since the effect depends upon the point of the voltage wave at which the transformer is disconnected as well as that at which it is reconnected.

The large Buffalo transmission transformers showed this effect to a large degree. Sometimes the closing of their switches would show no effect whatever, and at others there would be a tremendous jar and shock as if they had been struck with a huge sledge hammer. That there was a considerable mechanical shock on these occasions was shown by the fact that great clouds of dust inside the transformer would be loosened up whenever it occurred.

This effect is one which becomes noticeable only on low-frequency circuits, since it requires the iron to be worked fairly well up towards magnetic saturation as is the case in low-frequency transformers only.

Another incident noted in connection with these transformers is possibly worth repeating. On a number of occasions it was reported that upon throwing in the transformers, sparks from the transformers and other indications of short circuit were seen. On at least one occasion the transformers were pulled off the circuit with the full expectation of finding them burned out. However, rigid tests were applied without finding the slightest indication of trouble. By observation the cause was finally determined.

When throwing on the transformers under some conditions, the change in magnetic flux is very rapid during the first instant of connection. The laminated iron of the transformer itself forms a secondary in which a voltage is generated. Under normal conditions there is ample insulation between these laminæ to prevent a current flowing, but under the excessive strain that sometimes occurs at the instant of connection, this partially insulated circuit breaks down, thereby giving rise to the effect noted. After one knows all these things, they seem perfectly simple and natural, but previous to that they are matters of much anxiety.

The primary object of this article has been simply to record some of the more interesting events that happened at the Niagara plant during my sojourn there. These are a few of the incidents of operation that one is sure to get in such a plant. It is the integration of such items that makes experience.

Sanction has been given for the carrying out of what is known as the Kashmir project in the State of Mysore, India, and plans are under way for a hydroelectric station capable of furnishing 17,000 horse-power, which is to supply power for an electric railroad 200 miles in length, for a large dredging outfit, and for lighting and other power purposes. It is not at all improbable that the single-phase alternating-current system will be used on this road.

The blast furnace is not suitable for the reduction of titaniferous iron ore. But in the electric furnace it is possible to obtain a final product containing a large or small percentage of titanium as desired. The advantage of the treatment of titaniferous iron ore, vast quantities of which exist in the United States, lies in the value of the by-products, particularly the ferro-titanium and titanium carbide.

The Selection of Incandescent Lamps

THE judicious selection of incandescent lamps, says "The Electrical Review," of London, involves problems of a very different and much more difficult character than the selection of most other articles of every-day commerce, and out of the multiplicity of makes of lamps of all prices and efficiencies which are sold at the present day, it is absolutely impossible to single out one particular make as being the most suitable for use under any and all circumstances and conditions.

Yet, notwithstanding this undoubted impossibility, it appears to be the usual practice for the great majority of lamp manufacturers and selling agents to invariably claim that their particular lamp is the best, cheapest, and in every way most economical lamp on the market; and in many instances they back up their claims by giving figures which purport to prove that their statements have, in practice, either been substantiated or more than substantiated.

These extravagant claims are, of course, taken at their true value by those who are conversant with the technicalities of the question; but what about the average consumer who is, as a rule, totally ignorant of these matters and without any means of testing or checking in any way the many conflicting statements? How is he to choose between one lamp and another except by the bitter experience method, ending probably with dissatisfaction at electric lighting generally?

It may, perhaps, be permissible to point out that the real root of the problem of the most suitable lamp to use consists not simply in the ascertaining of the most efficient or the cheapest lamp on the market, but in the obtaining of candle-power-hours at the lowest total cost. One of the most important determining factors in deciding this cost, one which is only too often completely overlooked, is the cost of electrical energy with which the lamp or lamps are to be supplied.

In cases where electrical energy is cheap, the efficiency of the lamp is not such an important factor as its life and the cost of lamp renewals, and conversely in cases where electrical energy is dear, the efficiency of the lamp is the most important item, and that of life and of cost of lamp renewals is only of secondary importance.

The relative values of the various items composing the total cost per candle-power-hour set forth in a

formula which may be put thus:—

Total cost per candle-power-hour = total cost of lamp divided by life in hours $\times$ average candle-power + average watts per candle-power $\times$ cost of 1 watt-hour of electrical energy.

The particular lamp which enables the lowest result to be obtained in this formula is from the consumers' point of view the best—the most economical—lamp to use, quite independent of any difference between it and other makes of lamps, either as regards cost or efficiency. The serious difficulty, however, in the practical application of this formula is that several of the factors which have an important bearing on the result, can only be reliably ascertained by means of a series of extended tests under actual working conditions, requiring, in addition to a supply of current, technical instruments, and more or less of a technical training to manipulate them. This difficulty, which is, of course, unfortunately inherent to the problem under solution, is the crux of the whole question, and is, indeed, essentially the primary reason why the great majority of consumers have, hitherto, had no option but to choose their lamps on blind, haphazard, rule-of-thumb methods, the evil effects of which, needless to say, are daily becoming more and more manifest.

There seem to be for supply undertakings but two alternative methods of dealing with this difficulty, either that it should be boldly tackled or that it should be calmly ignored; the latter method is, of course, the easier, and up to the present the one generally adopted in Great Britain. Should there be schemes formulated in the near future by supply undertakers with the former method in view, the following suggestions may possibly contain some point which might be usefully incorporated, as there is every probability that it will be on somewhat similar lines that such schemes will, in practice, be most advantageously worked:

(a) The supply undertakers to institute, as part and parcel of the working of the station, the careful and systematic testing of the various makes of lamps on the market for candle-power, current, and life.

(b) The lamps to be tested in batches of, say, half-a-dozen of each make at a time, and purchased if possible locally, so as not to obtain lamps specially picked out for the purpose of the test.

(c) To keep in touch with lamp manufacturers and selling agents as to the net price at which they are prepared to sell lamps to consumers, in varying quantities, in the town under note, either directly, or through the local wiring contractors.

(d) Working out all results in accordance with the formula previously mentioned herein, or any similar formula, which duly takes into account the various factors concerned.

(e) Tabulating all results so that they may be available for ready reference.

(f) Half-yearly or yearly summing up the results of the tests, and picking out the four, five, or six makes of lamps which have given the best all-round results.

(g) When the accounts for energy are sent out, a note or printed slip to be added in a prominent position, informing the consumer that, as the local supply undertakers are, at all times, anxious to promote, as far as possible, the efficiency of electric lighting, and as it has been brought to their notice that a considerable amount of harm has been done owing to the use of unsuitable lamps by consumers, due to their lack of guidance on this matter, the supply undertakers have carried out a series of careful tests upon the various makes of lamps on the market, when used under ordinary working conditions, and with the current as supplied locally, and that the results had been, taking into consideration the candle-power, consumption of power, price of energy, life, and cost of lamp, that the following four, five, or six (as the case may be) makes of lamps have been found to be decidedly the cheaper and more suitable to use locally.

The note should also add the fair market prices at which such lamps can be obtained in varying quantities in the town under note.

It will be at once apparent that there is one outstanding difficulty which the suggestions make no attempt to cope with, namely that due to consumers continuing to use their lamps long after they have become blackened and extremely inefficient. To the writer, however, it appears that, as this is entirely an ordinary simple commercial question, variations of which, in one form or another, the consumer is probably dealing with scores of times every day, it would be the most feasible plan to attempt to educate the consumer, either by means of pamphlets and notices, or by a little personal advice now and again, to appreciate the point for himself. Furthermore, it is most difficult to see how the supply undertakers could themselves deal with this question satisfactorily on their own responsibility, except at considerable expense.

Fire Alarm Service in New York

THE report of the committee, appointed last December by the New York Board of Fire Underwriters, to investigate the existing conditions of the fire alarm service in the borough of Manhattan was recently made public.

The committee engaged Kempster B. Miller and J. J. Carty, both well-known electrical engineers, the former to conduct the investigation and the latter to serve as consulting engineer. After a thorough investigation of the present system, Mr. Miller states that it is in a most deplorable condition and liable at any time to become practically useless to the fire department. He recommends an entirely new fire alarm system, different and distinct from the one now in use, as the only remedy for the case.

Mr. Miller's suggestions have been approved by Mr. Carty, and are briefly as follows:—A single fireproof central office is to be located immediately south of Central Park and to contain the necessary electrical apparatus and conductors. The building itself is to be used for no other purpose than as a central office for the fire alarm system, to contain no skylights or other openings through which falling objects will be liable to interrupt the service, and to allow for numerous cable approaches so as to insure freedom from breakdowns. The fire alarm cables are to be rubber-covered and lead-encased, and the telephone cables to be twisted, paper-covered, and lead-encased. The electrical apparatus and exposed conductors within the central office are to be mounted at such a height above the floor as to protect them from the accumulation of water resulting from the breaking of a water main, or from a cloudburst; and the telephone service between the central office and the various department houses to be supplied by the telephone company serving New York City, rather than by the city itself.

It is remarked in "Power" that if there is any place on the ordinary steam engine where the ignorant factor of safety is overdone—surplus iron and strength—it is in the pillow-blocks and never in the fly-wheel, as it costs much money to get it in the latter place, and little or none to get it in the former. Consequently, there is a continual wreckage of fly-wheels. Most of the wrecks of the above character are of wheels operated by single or tandem engines.

Artificial Illumination—VI

By Dr. EDWIN JAMES HOUSTON

Continued from the October number

STREET ILLUMINATION

THE out-of-door illumination required for the proper lighting of such extended areas as parks, squares, roads or streets may be regarded as an instance of direct illumination. Here the sources of light, such as oil lamps, gas lights, arc and incandescent lamps, are placed so that their light can be thrown directly on the space to be illuminated; i. e., on the surface of the ground or streets. Illumination of this character differs markedly from indoor illumination, in which the diffusion or irregular reflection of the light from the walls and ceilings of the rooms permits a fairly considerable amount of light to be thrown on the objects that are to be illumined.

In the case of street illumination, there is nothing to reflect or diffuse the light, except in densely populated districts, where the fronts of houses or buildings give considerable aid in this direction. Since, in early street lighting, it was intended that the light should fall directly on the surface of the street, the globes or lanterns employed to protect the light from the wind and weather were made of transparent glass.

The advantages which are now universally recognized as being derived from the employment of surface sources of artificial light, as distinguished from point sources of light, have led to the general employment of diffusing globes around the sources of light, so that in nearly all cases the electric arc lamps employed for street lighting are now provided with diffusing globes. In this sense, therefore, street lighting may be regarded as a species of indirect lighting, in which the light is caused first to illumine the surface of a surrounding globe that is formed of frosted glass or translucent porcelain.

A marked difference exists between out-of-door illumination and interior illumination, not only as regards the quantity of the light, but also as regards the character of the light. The average amount of light required for out-of-door illumination is far less than that required for indoor illumination, since no particular work is done in the street save that of safely moving from place to place. This, of course, does not include the lighting of store windows, which is to be regarded as a variety of indoor illumination.

The fact that no work is to be done in the street makes it unnecessary to ensure the same steadiness of light that is required for the carrying on of any fine work, as in a machine shop, mill, or other similar location, nor is the character of the light as regards its approach to daylight values a matter of much importance, since the natural colours of surrounding objects are not necessary, although, of course, the steadier the light and the more nearly it approaches sunlight values in its colours, the better and more satisfactory will be the illumination.

The artificial illuminants employed to-day for the lighting of streets are the ordinary oil and gas lights, the Welsbach and other incandescent mantle gas lights, and electric, incandescent and arc lights of various types. Of these, we may safely pass by the different forms of oil and simple gas lights as illuminants of the past. Under certain circumstances, the various types of incandescent mantle lamps are capable of giving effective illumination for the streets in suburban districts, or for country roads. The electric light, however, is by far the most efficient source of artificial illumination for streets and large areas generally, and is now commonly employed for such purposes.

In the early history of electric lighting, as is well known, the illumination of streets and large areas generally was effected by open electric arc lamps,—i. e., arc lamps provided with open and generally clear glass globes. These arc lamps were of two different types: long arcs, or those employing pressures in the neighbourhood of 50 volts, and short arcs, or those employing pressures of about 35 volts between the carbons. The lamps of the first type required currents of about 9.5 amperes, and produced the so-called 2,000 nominal candle-power lights. As is well known, however, this lamp, while sometimes giving a candle-power in the most favourable direction as high as about 1750 candles with the crater in the positive carbon all exposed on one side of the carbon, yet, generally speaking, it gave, at an angle of 45 degrees to the horizontal, an average effective maximum illumination of not more than about 1,450 candles, and frequently much less.

The principal objections to street lighting by open direct-current arc lamps are:—

(1) The high intrinsic brilliancy of the light produced.

(2) The poor distribution of the light, the direction of maximum illumination being unfavourable to the uniform lighting of extended areas.

(3) The rapid consumption of carbons, requiring the frequent recarboning of the lamp. Carbons employed in open arc lamps require, generally speaking, to be renewed every day during the winter, as they last only from 10 to 12 hours, while those employed in enclosed lamps last for periods varying from 60 to 125 hours.

(4) The marked unsteadiness of the light.

The open-arc carbon lamps were originally operated by means of direct currents. At a later date they were also operated by means of alternating currents.

The many advantages that are now recognized as being possessed by enclosed arc lamps,—i. e., lamps the carbons of which are surrounded by an air-tight glass globe so that the carbons are soon surrounded by an atmosphere free from oxygen,—have led to the rapid replacing of the open arcs by the enclosed arcs. Indeed, although the enclosed arc lamps were not introduced until about the beginning of the twentieth century, yet more than 1,000,000 enclosed arc lamps are employed at the present time in different parts of the United States. Enclosed arc lamps can be operated either by direct or alternating electric currents.

While the amount of light produced by any artificial illuminant goes a considerable ways toward determining its suitability for the il-

lumination of such areas as streets, yet the quantity of light is by no means the only important consideration. The general direction in which a luminous source projects its maximum light is also a matter of considerable importance. Now, while the amount of light emitted by an

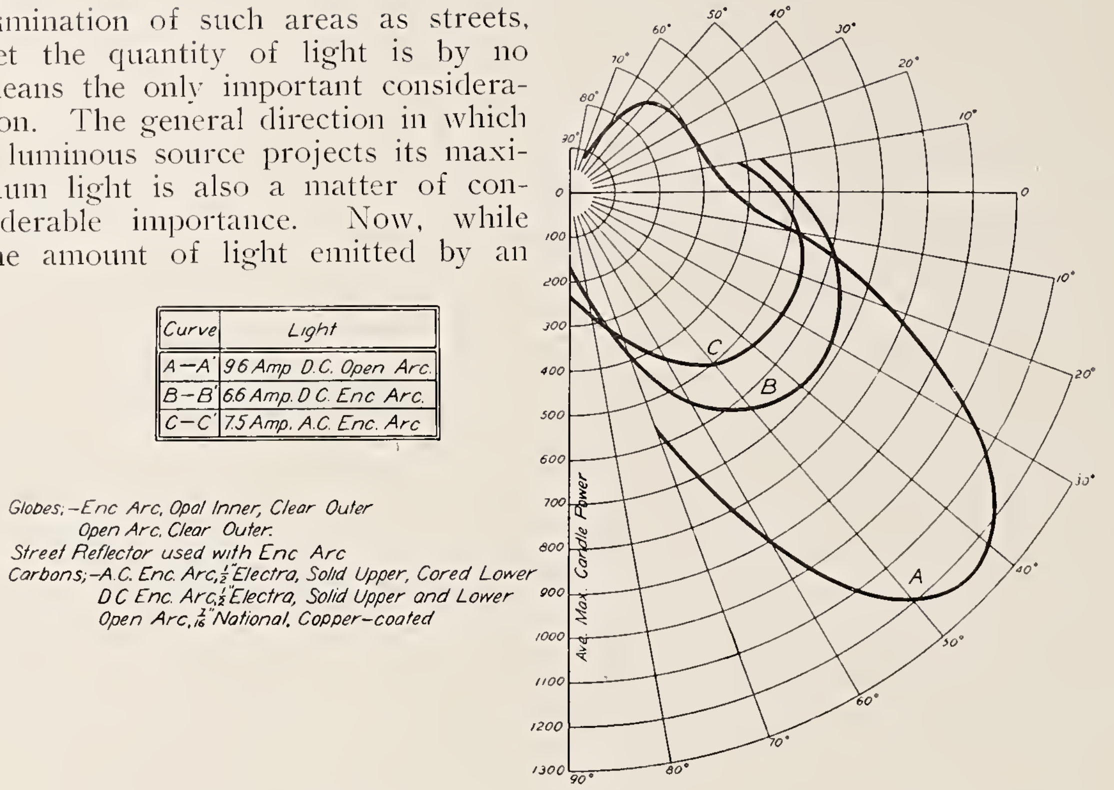


FIG. 1.—CURVES OF LIGHT DISTRIBUTION FOR OPEN AND FOR ENCLOSED ARC LAMPS

open direct-current arc lamp is greatly in excess of that emitted by the enclosed arc lamp, yet the direction of its maximum rays is far less satisfactory. It will, therefore, be necessary to discuss the peculiarities of the open and the enclosed arc lamps as regards the direction of their maximum rays in order to understand their suitability for the illumination of streets.

In an open arc lamp operating at, say, 9.5 amperes, the length of the arc is in the neighbourhood of $\frac{1}{8}$ of an inch. Under these circumstances, only about 10 per cent. of the total light is emitted by the arc itself, 5 per cent. coming from the heated carbons, and the remaining 85 per cent. from the crater at the end of the positive carbon. For this reason, the intensity of the light emitted in any given direction will be approximately proportional to the extent of the crater visible in that direction. When the arc is situated at the center of the carbons, and is normal, the largest proportion of the crater is visible at an angle of about 45 degrees, so that it is in this direction that the maximum amount of light is emitted.

An inspection of the curve *A*, Fig. 1, shows that the light emitted by an open direct-current arc lamp is practically limited to a long, narrow lobe, the maximum intensity of which is inclined to the horizontal at an angle of 45 degrees. As shown by this figure, the lower carbon practically intercepts all the light at an angle of 70 degrees below the horizontal, thus throwing a shadow on the ground immediately beneath the lamp. It is this shadow that forms the principal objection to the employment of direct-current open arc lamps for the illumination of streets.

Let us now examine the peculiarities of the enclosed arc lamp. In these lamps there is produced a long arc in an atmosphere that is practically free from oxygen. While, as in the case of all arc lamps, the greater proportion of light comes from the crater in the positive carbon, yet in the enclosed arc lamp a greater proportion is emitted from the arc than in the case of the open arc lamp, on account of the greater length of the arc in the enclosed lamp. Moreover, by reason of this greater length of arc in the enclosed lamp, a larger proportion of the area of the crater is visible from a wider angle, and, moreover, the crater is not as concave as in the open arc lamp, so that the concentration of the light is less marked, and its general distribution much improved. This peculiar distribution of the light of the enclosed arc lamp is well adapted for street illumination.

Referring again to Fig. 1, there will be found the curves of distribution, not only for the open arc lamp, but also for enclosed arc lamps operated by direct current and by alternating current. In this figure, *B* represents the distribution of light produced by a 6.6-ampere direct-current enclosed arc lamp, and *C* that of a 7.5-ampere alternating-current enclosed arc lamp. Noting the shape of the curve *B*, it will be observed that this lamp throws an average light of somewhat less than 300 candle-power immediately below it, while the lamp represented by *C* throws a light of nearly 400 candle-power immediately below it.

The effects produced by the peculiarities attending the distribution of the light in the case of the three forms of arc lamps represented in Fig. 1, can best be understood from an inspection of Fig. 2, from Ryan, representing the street illumination curves calculated from the preceding power curves.

Here the values are given in can-

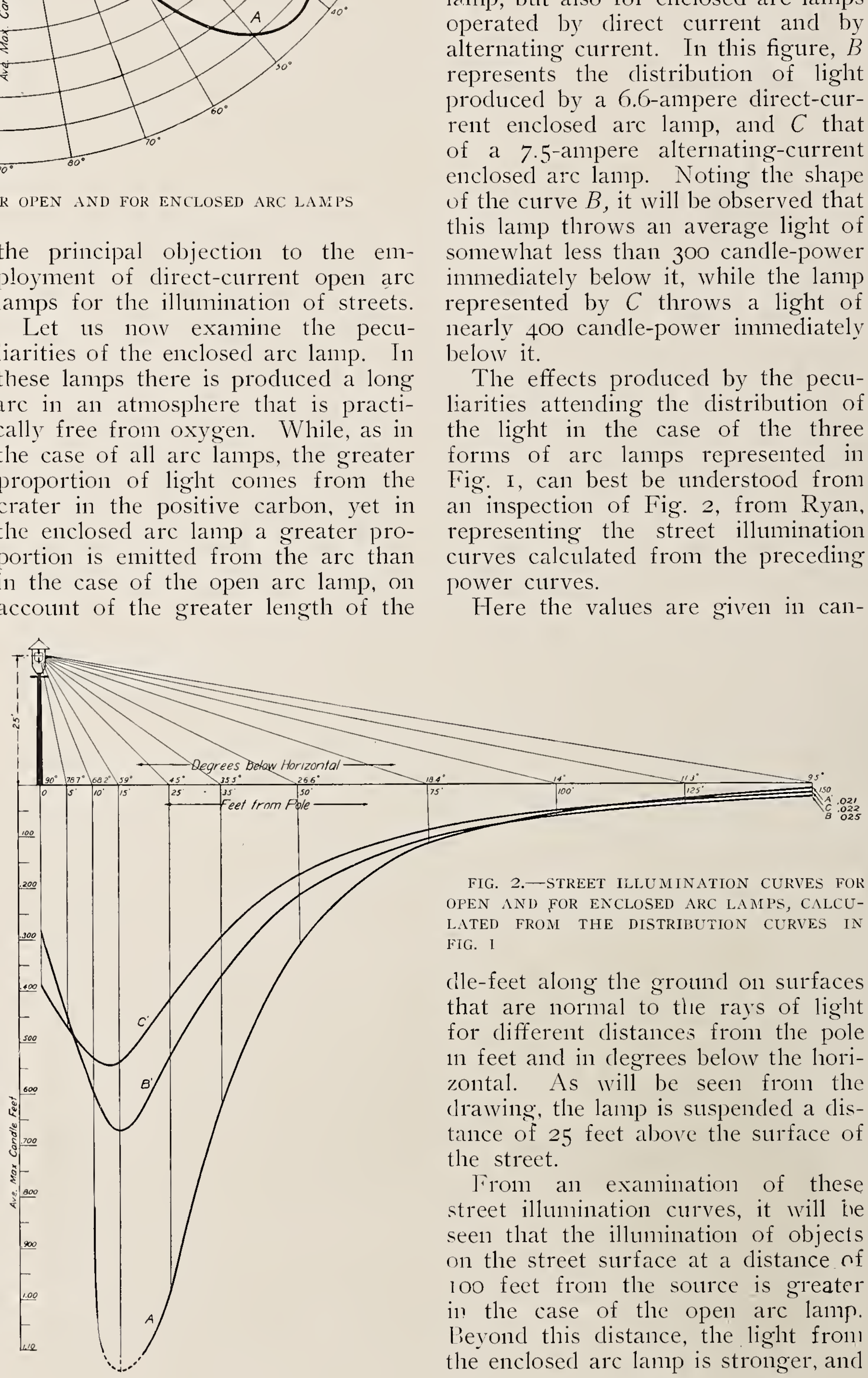


FIG. 2.—STREET ILLUMINATION CURVES FOR OPEN AND FOR ENCLOSED ARC LAMPS, CALCULATED FROM THE DISTRIBUTION CURVES IN FIG. 1

dle-feet along the ground on surfaces that are normal to the rays of light for different distances from the pole in feet and in degrees below the horizontal. As will be seen from the drawing, the lamp is suspended a distance of 25 feet above the surface of the street.

From an examination of these street illumination curves, it will be seen that the illumination of objects on the street surface at a distance of 100 feet from the source is greater in the case of the open arc lamp. Beyond this distance, the light from the enclosed arc lamp is stronger, and

FIG. 3.—A STREET LIGHTED BY 6.6-AMPERE LAMPS 400 FEET APART, ACCORDING TO THE SYSTEM OF THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

at 150 feet from the source it is considerably in excess of the open arc lamp. Moreover, since in the case of the enclosed arm lamp the intensity of the light is not so great in the immediate vicinity of the lamp, the light is more effective. For these reasons the so-called 2000 nominal candle-power open arc lamp can be replaced lamp for lamp by enclosed continuous-current arcs taking about 6.5 amperes, not only with no loss, but actually with a marked improvement in the general effect of the illumination.

Enclosed arc lamps possess the advantage that the length of the arc is preserved practically constant at all times. In enclosed arc lamps, the variations in the intensity of the light are due to the traveling of the arc over the flat ends of the carbons. Where the arc is maintained at the center of the carbons, the lobes marking the distribution of light are equal on the opposite sides of the arc. When, however, the arc travels to one edge of the carbons, the lobe necessarily becomes enlarged on one side and diminished on the opposite side.

Although these changes take place, the mean spherical candle-power of enclosed arc lamps is practically the same at all times. Moreover, the use of the opal enclosing globe employed in the enclosed arc lamps results in a marked decrease in the variations of the light, owing to the fact that the illumination is due to surface illumination and not to point illumination. The globe is rendered luminous over its entire surface, and this prevents the formation of shadows of the lower carbon and the side rods of the lamp.

In addition to the advantages already referred to, enclosed arc lamps possess marked advantages over open arc lamps in the following respects:—

(1) Saving of the carbons.

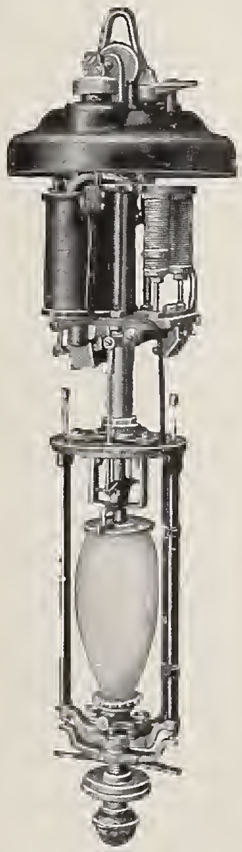
(2) Decreased labour necessary for retrimming. This naturally results from (1).

(3) Safety, owing to the absence of flying sparks.

(4) Greater cleanliness, owing to the absence of carbon dust present in the case of the open arc lamp.

(5) Increased simplicity in the mechanism of the lamp, and, therefore, less liability to get out of order.

Enclosed arc lamps, however, possess one objectionable feature,—i. e., the increase in the length of the arc is accompanied by an increase in the amount of bluish or violet rays. This peculiarity of the light, however, is not a matter of very great import-



Without Casing

With Casing

FIG. 4.—DIRECT-CURRENT SERIES ENCLOSED ARC LAMP WITH CLOSED BASE OUTER GLOBE. MADE BY THE GENERAL ELECTRIC COMPANY

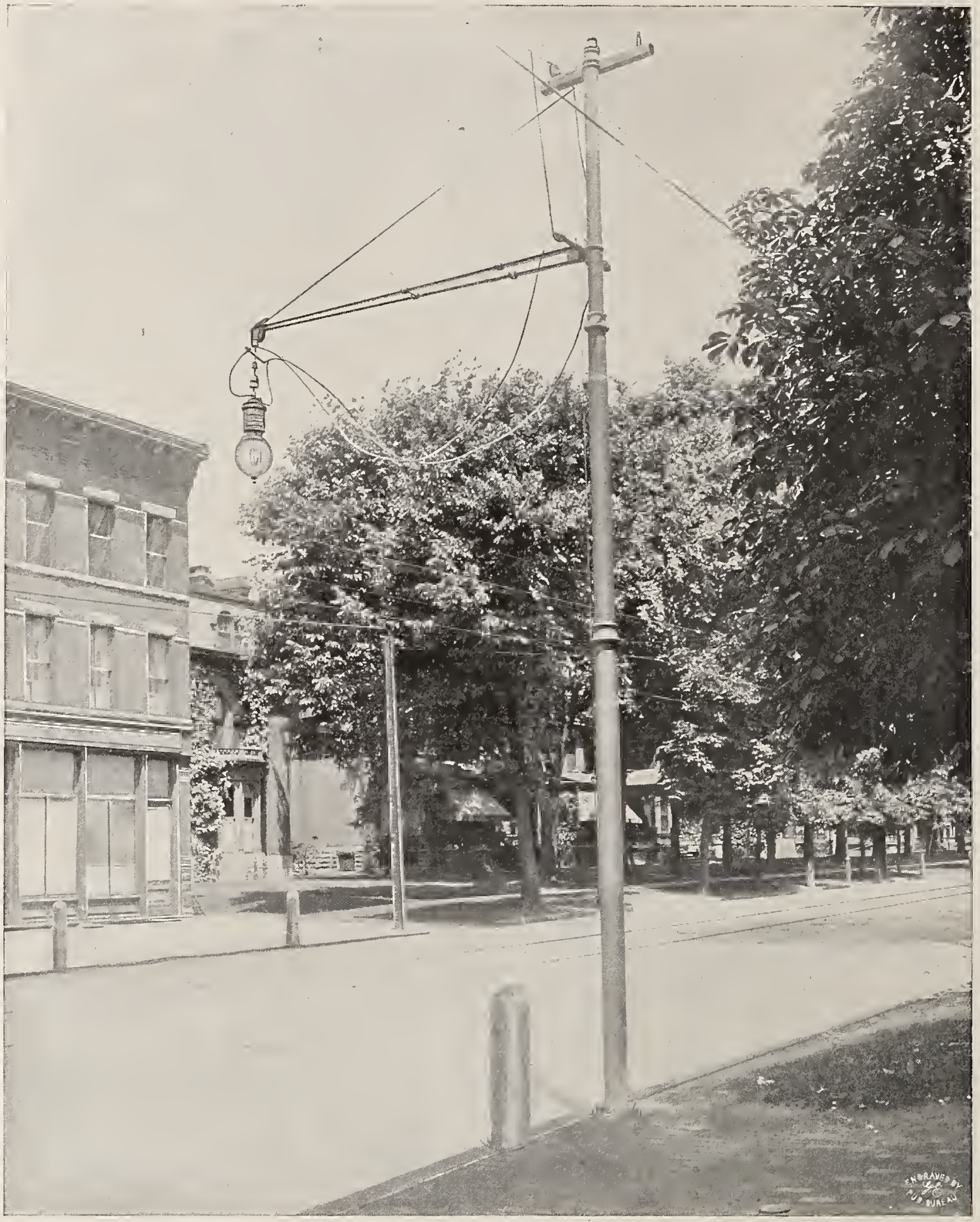


FIG. 5.—A MAST ARM SUSPENSION OF ARC LAMPS AT BUFFALO, N. Y.

ance where the lamps are employed for out-of-door illumination, such as the lighting of streets. Even for indoor illumination, the use of a suitable enclosing globe can, to a great extent, relieve this objectionable feature.

In street illumination, as in the illumination of shops and interiors generally, it is important to prevent the light from the lamp or other luminous source from falling directly on the eye of the observer, since the effect of too great an amount of light results not only in a decreased sensitiveness of the retina, but also in the contraction of the pupil, thus limiting the amount of light that can enter the eye. Arc lamps employed for street illumination should, therefore, be suspended at such a height above the street surface as to decrease the probability of the light directly entering the eyes of the people on the street. Where the streets to be lighted are free from trees, an advantage is gained by suspending the lamps at distances of from 25 to 30 feet above the pavement, since, in this manner, a greater area of street surface can be readily lighted by the downwardly projected rays of maximum intensity.

As regards the amount of light necessary for street illumination, it may be remarked that between the latitudes of Boston and Philadelphia, the average amount of illumination produced by moonlight varies from 0.01 to 0.03 candle-foot, so that the minimum amount of light produced for the proper illumination of a street should never be less than 0.03 candle-foot, and preferably should be somewhat greater. When a system of cross-suspension of lamps is employed for streets where the foliage is not too low, an advantage is gained by placing the lamps at distances of from 18 to 20 feet above the surface of the street.

The distance between arc lamps employed for street illumination will, of course, vary with the amount of illumination required. For densely populated cities, with buildings on each side of the street, a fairly good illumination can be obtained by employing two arc lamps for each block, or for the distance between two contiguous streets. As one of these two

FIG. 6.—STREET LIGHTING AT BUFFALO, N. Y., SHOWING INSTALLATION OF GENERAL ELECTRIC DIRECT-CURRENT SERIES ARC LAMPS

lamps should be placed at the intersection of the streets, thus permitting it to throw its light up and down the two streets, the other lamp should be placed midway in the block. For suburban districts, a single lamp at distances equal to that between two contiguous streets is used, although frequently the distance between lamps is much greater.

Some idea of the character of the illumination produced in a street by means of series enclosed arc lamps consuming 6.6 amperes, 400 feet apart, can be had from an inspection of Fig. 3. This is an installation of the General Electric Company, Schenectady, N. Y. It will be noted that the street is bordered by shade trees, so that a uniform illumination is difficult.

In the spaces between the lamps, however, the illumination is quite sufficient to permit the details of the surroundings on the side of the street to be fairly visible.

It is unfortunate that in street lighting so little light can be derived from diffused light thrown off from objects on which the light falls. Of course, as already remarked, where there are buildings on each side of the street, especially where such buildings are tall, the general illumination of the surface of the street will be greatly improved by diffusion from the buildings. In the absence of such buildings, however, it is only the direct light that can be relied upon for illumination. This is usually the case since the surface of any ordinary street or road is of such a nature as to absorb rather than to throw off or diffuse the light. Where the surface of the road is formed of better diffusing substances, such as white sand or shell limestone, a much better illumination will be obtained from the expenditure of a smaller quantity of light.

The general illumination on a

street or road is far better when there is a covering of snow, since this material possesses considerable power for diffusing the light that falls on it. The same effect may also be observed, although to a less degree, in the case of wet streets or roads. Here, however, the advantage is greater where the light regularly reflected from the wet surface can again be thrown on the surface of the road by adjacent buildings. An improvement in the illumination of streets and roads generally, might be obtained by giving more attention to the character of the road surface as regards its ability of irregularly scattering the light. Of course, no little difficulty would be experienced on obtaining a road covering that possessed in any great degree the power of diffusing light. Generally speaking, however, light-coloured surfaces could readily replace the dark-coloured surfaces so common on most roads.

The electric illumination of streets is effected by means of different systems, the more important of which are the following:—

(1) Direct-current series enclosed arc lamp system.

(2) Alternating-current series enclosed arc lamp system.

(3) Alternating-current series incandescent electric lamp system.

Besides these there are various systems of multiple connected lamps, both for direct current and for alternating current. Street lighting with direct-current series enclosed arc lamps possesses advantages over street lighting with open arc lamps, as already referred to.

Fig. 4 represents a form of direct-current series enclosed arc lamp made by the General Electric Company. It is shown both with and without an outer globe casing. The lamp mechanism is provided with two spools, each of which has a shunt and a series winding. An adjustable resistance is connected across the series coil, and a small starting resistance is placed in series with the cut out. The standard adjustment of lamps of this type is for 6.6 amperes and 77 volts, or 508 watts across the terminals of each lamp. The adjustment of the arc is for 75 volts, or 495 watts.

The open base enclosing globe form of this lamp is especially suitable for street lighting, and is being rapidly installed in the cities and towns of the United States. According to the General Electric Company, one of the largest direct-current series arc lamp installations, that at Buffalo, N. Y., includes 3200 arc lamps, together with the necessary accessories. It will be noticed that the amperage of 6.6 employed in these lamps is much less than that employed in the old form of open arc lamps, which was about 10 amperes. The old Brush machine armatures wound for 9.6 amperes, were in this case rewound to produce the necessary 6.6 amperes. The carbons employed in direct-current series enclosed arc lamps consist of the standard 12 inches by $\frac{1}{2}$ inch solid carbons.

In the Buffalo installation before referred to the mast arm suspension is employed, as shown in Fig. 5.

Fig. 6 represents another plan

FIG. 7.—GENERAL ELECTRIC DIRECT-CURRENT MULTIPLE ENCLOSED ARC LAMPS ON FIFTH AVENUE, NEW YORK CITY

adopted for the support of the arc lamps employed in the street lighting at Buffalo, N. Y., for this system of direct-current series arc lamps. Here the two lamps are supported at the top of an ornamental pole. As in the preceding case, the wires furnishing the lighting current pass from underground conduits up through the center of the poles to the lamps and back again to the conduits.

Besides the employment of direct-current series enclosed arc lamps for street lighting, it is often a matter of convenience to connect these lamps with the circuits running from the constant-potential mains used for supplying electric incandescent lamps or street railway cars. In such cases the arc lamps are placed either singly on the direct-current multiple circuits, or in series on such circuits. When intended for operating singly on direct-current multiple circuits with pressures of from 100 to 120 volts, the arc voltage of the lamp must be reduced by means of a suitable resistance coil. This coil is wound on a porcelain drum provided with a spiral groove moulded in its face, so as to prevent the sagging of the resistance wire when highly heated.

Where a number of arc lamps are employed in series on multiple circuits, the regulating resistance is used as with series lamps. When, as in the case of incandescent lamp circuits of from 220 to 250 volts, two incandescent lamps are employed in series, one resistance is made to serve both these lamps, while in multiple circuits of from 550 to 600 volts, as in street railways, five lamps are connected in series, and are operated with two such resistances.

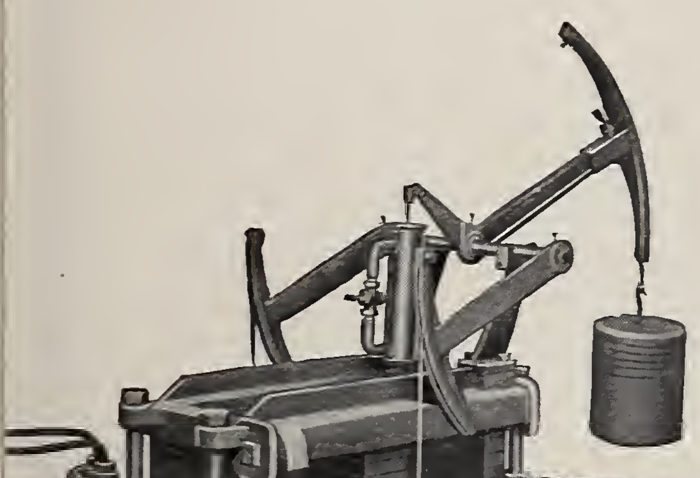


FIG. 9.—A 35-KW. AIR-COOLED CONSTANT-CURRENT TRANSFORMER WITH CASING REMOVED. MADE BY THE GENERAL ELECTRIC COMPANY

Fig. 7 shows the street lighting system on Fifth avenue, New York City, with direct-current multiple connected, enclosed arc lamps made by the General Electric Company.

Fig. 8 represents a form of pole support for two direct-current series enclosed arc lamps. In this form of support, the wires carrying the current are led up the center of the pole, the distribution of the wires being made through underground conduits.

In the series arc system of street lighting, as in all series systems, the current in the line is necessarily of constant strength. Since in systems of street lighting the number of lamps in series on a circuit necessarily varies from time to time, due to the cutting in of new lamps, or the cutting out of lamps already in service, some method is necessary to ensure the presence of a constant current as the resistance varies in the line. This is done, in the case of dynamos for producing the direct currents for series arc lighting, by varying the electromotive force.

Various methods have been employed for thus varying the electromotive force of the dynamos or generators employed for street arc lighting systems. Some of the principal methods are as follows:—

(1) By compound winding on the dynamo. This method is especially suitable for use in constant-potential machines. By employing this winding, the magnetizing effect of the shunt coils is maintained approximately constant, while that of the series coils varies proportionally to the load on the machine.

(2) By shifting the position of the brushes on the commutator. This method, as employed in the Thomson-Houston system of current regulation, consists in the automatic shifting of the brushes to such points on the commutator as will result in the production of an electromotive force capable of maintaining the current strength constant, no matter what resistance has been introduced into or removed from the line by the cutting in or out of lamps.

(3) By the automatic variation of a resistance shunting the field magnets of a machine, as in the case of the Brush system.

(4) By the introduction of a variable resistance into the shunt circuit of the machine, as in the Edison and other systems.

(5) By various methods of dynamometric governing, in which a series dynamo is made to yield a constant current by the governing of the steam engine that drives it, by means of a dynamometric governor.

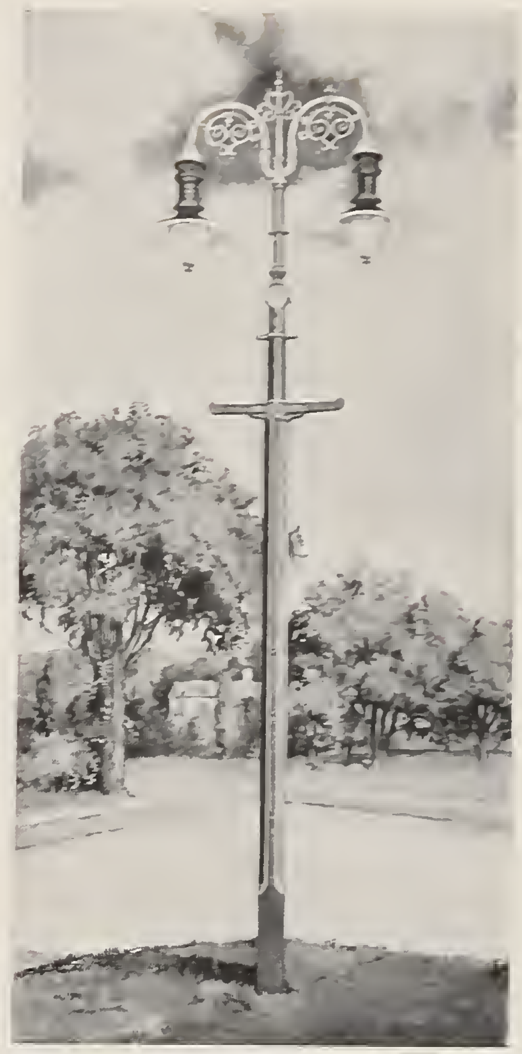


FIG. 8.—ORNAMENTAL POLE FOR INSTALLING TWO ARC LAMPS

In the case of the alternating-current generators employed for series systems of arc lighting, the varying electromotive force of the current is obtained by the use of devices called constant-current transformers. Transformers of this character are employed for both arc and incandescent electric lamps.

Fig. 9 represents the construction of a constant-current transformer made by the General Electric Company for series-connected incandescent lamps. This transformer consists of a core of the double-magnetic circuit type provided with three vertical limbs and two flat coils enclosing the central limb. These coils constitute the primary and the secondary of the transformer. The lower coil, constituting the primary, is fixed, while the upper coil, which constitutes the secondary, is free to move along the central limb of the core, being carried on a balance suspension.

The secondary coils are suspended by means of two cables from a mechanism which consists of a lever supported by knife-edge bearings on hardened steel tables, clamped to the

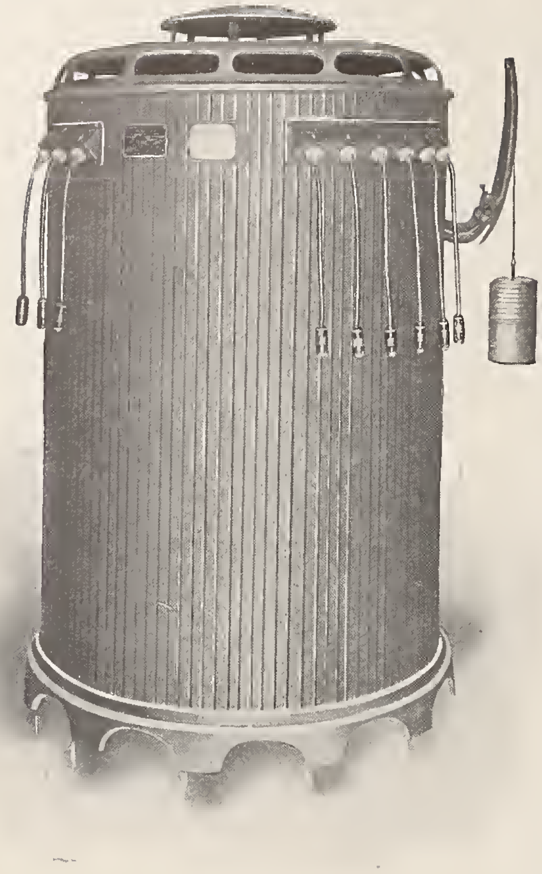


FIG. 10.—A 100-LIGHT AIR-COOLED CONSTANT-CURRENT TRANSFORMER, WITH TAPS FOR OPERATION AT PARTIAL LOAD, WITH FULL LOAD POWER FACTOR. MADE BY THE GENERAL ELECTRIC COMPANY

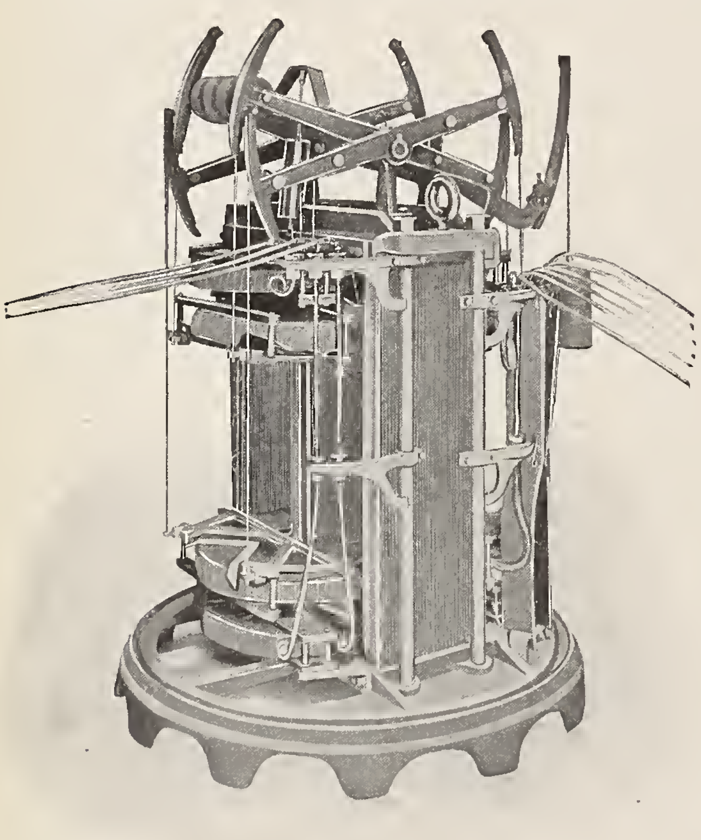


FIG. 11.—THE CONSTANT-CURRENT TRANSFORMER SHOWN IN FIG. 10, WITH CASE REMOVED

top of the core. One end of the lever is provided with two fixed arcs, as shown, from which are suspended the cables supporting the movable coil. At the outer end of the lever, an adjustable arc carries a counterweight by means of a cable suspension. This counterweight is adjusted sc as to exactly balance the weight of the movable coil less the amount of electric repulsion, due to the passage of the normal currents through the coils. Within the limits employed in actual working, the electric repulsion between the fixed and movable coils is directly proportional to the current flowing. Consequently, the transformer is capable of being adjusted so as to maintain the current constant within any limits, by simply varying the amount of the counterweight.

As the counterweight is equal in amount to the weight of the coils less the electric repulsion, reduction in the counterweight will necessarily result in an increase in the strength of the current.

The regulation of the current strength is effected by this device as follows: The passage of the current through the primary and secondary coils results, by their mutual repulsion, in their separation by the movement of the movable coil until the equilibrium is restored. The current corresponding to this position of equilibrium is then adjusted by changes in the counterweights. Under these circumstances the coil will always take such a position as will maintain that current constant in the secondary coil regardless of any changes in the external resistance with which the coil may be connected. When a current whose strength is less than that of the normal passes in the circuit, the repelling force is diminished, thus permitting the primary and secondary coils to approach each other, in this manner restoring the normal current. When, however, the secondary current exceeds the normal current, the opposite action takes place.

When constant-current transformers are installed in stations where the generator capacity is limited, by reason of the low power factor of the system, then when the transformers operate at light load, a generator capacity greatly in excess of the actual load carried is necessary. In order to overcome this difficulty 25, 50 and 100-light, 60-cycle air-cooled constant-current transformers have been designed by the General Electric Company, with taps to give approximately full load power factor and efficiency when the transformers are operated at partial loads.

Fig. 10 represents a 100-light air-cooled constant-current transformer made by the General Electric Company, with taps for operation at partial load with full-load power factor. Fig. 11 shows the same transformer with the casing removed.

Oil-cooled, constant-current transformers originally were almost exclusively employed, but now are generally replaced by air-cooled transformers.

The adjustment of the constant-current transformer for arc lamps is similar to that for incandescent lamps. Within working limits, the electric repulsion between the fixed and the moving coil is proportional to the currents flowing in the coils, so that the transformer can be adjusted to maintain constant any current by simply changing the amount of the counterweight.

Constant-current transformers for arc lamps are sometimes made with two sets of moving coils balanced against each other. In this case, the counterweight merely serves to draw the primary and secondary coils together in opposition to the repulsion effect. A decrease in the counterweight is, therefore, followed by a decrease in the current. The arc on the counterweight lever is made adjustable, because the repulsion exerted by a given current flowing in the coils does not remain the same for all positions of the coils, but is greater when the primaries and secondaries are close together, and is less when the primaries are separated.

The form of constant-current transformers employed for series-con-

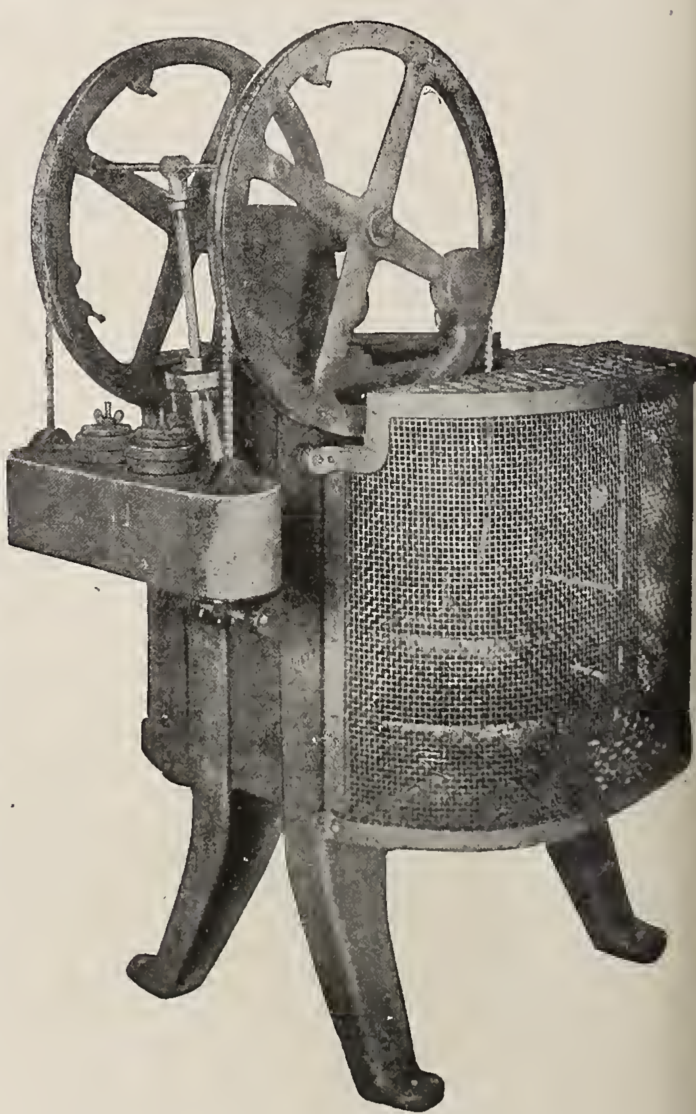


FIG. 12.—A 50-LIGHT AIR-COOLED CONSTANT-CURRENT REGULATING TRANSFORMER MADE BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURG, PA.

FIG. 13.—A 100-LIGHT OIL-COOLED CONSTANT-CURRENT TRANSFORMER MADE BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

nected arc lamps will regulate over a range from full load to one-third load. When properly adjusted, the current should be within 1-10 ampere of the normal for any number of lamps between full load and one-third load.

The efficiencies of constant-current transformers with full load of arc lamps at 60 cycles vary with the size of the transformer, and are equal to about 96 per cent. for the 100-light transformers, and 94.6 per cent. for the 25-light transformers. With a full load of differential lamps, the power factor is equal to about 76 to 78 per cent.

The constant-current transformer was originally designed to operate on single-phase circuits. It is now, however, employed on multi-phase installations, especially in the case of two-phase and three-phase transmission work where a constant-current transformer installed at the sub-station at the end of the transmission line, takes the place of a synchronous motor and direct-current arc machine.

The high pressures used on alternating-current series-connected circuits for arc lamps require, in order to insure the safety of the operator and freedom from interrupted service, the employment of exceedingly high insulation on the transformer. In order to ensure this insulation, the coils are first deprived of all traces of moisture in their insulating material, by being placed in a heated tank and subjected to what is known as the vacuum drying process. The windings are then impregnated with an insulating compound which permeates all the interstices of the insulation, and, when cool, leaves the wires evenly spaced throughout the solid mass of the insulating material. Coils so insulated are absolutely impervious to moisture.

Fig. 12 represents a constant-current regulating transformer made by the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., and capable of supplying fifty alternating-current series-connected enclosed arc lamps.

Fig. 13 represents an oil-cooled constant-current transformer also made by the Westinghouse Electric & Manufacturing Company, and capable of sustaining two 50-light circuits.

These transformers are of the repulsion coil type, and are designed to supply a constant secondary current, with the line thoroughly insulated from the primary circuit. For transformers the capacities of which are seventy-five lamps or less, there are provided a single stationary primary and a movable secondary, the secondary coil being so suspended on chains and balanced by weights that the repulsion between it and the primary will result in a change in the distance between the two coils with variations of the load; the induced current in the secondary is, in this manner, kept constant. The passage of the required current through the movable coil is such as to keep it balanced. Any increase in the current will increase the repulsion and cause the coils to separate, while a decrease in the current will cause the coils to approach each other until the normal balance is restored.

For transformers with capacities of from 100 to 150 lamps, two secondary coils are employed. A separate circuit of lamps may be operated from each secondary, the two circuits, when so desired, being operated with different currents.

Fig. 14 represents the connections of a constant-current regulating transformer on an alternating-series arc lamp system, designed by the Westinghouse Electric & Manufacturing Company.

As already mentioned, the constant-current transformer for series incandescent lamps is, generally speaking, the same as for arc lamps.

There is, however, this important difference: that while the arc lighting transformers are designed only for regulation to $\frac{1}{3}$ inductive load, and are capable of regulating to $\frac{1}{2}$ non-inductive load, the transformers for series incandescent lighting are designed for regulation to no load, and are

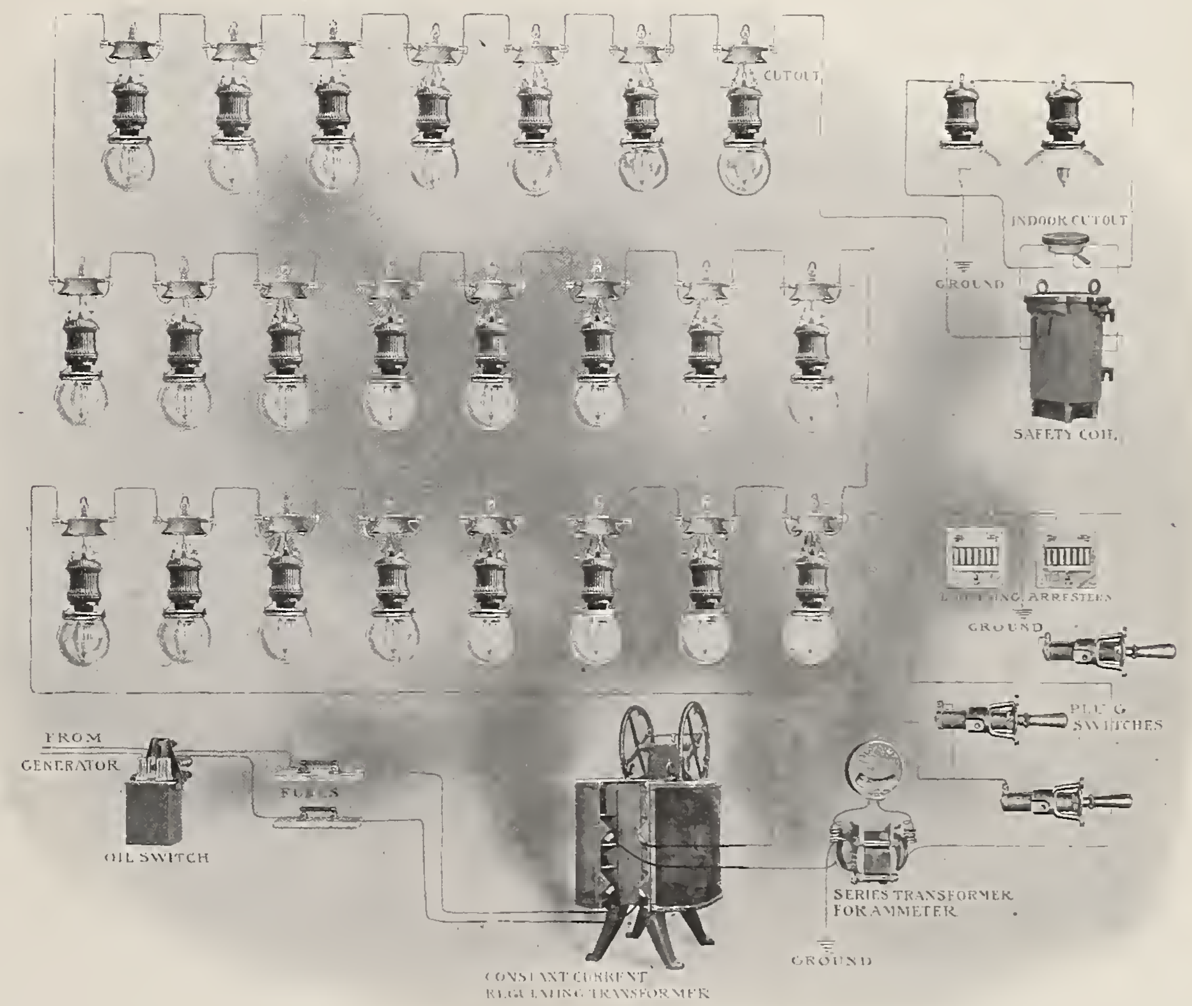


FIG. 14.- THE WESTINGHOUSE SERIES-ALTERNATING ARC LAMP SYSTEM

capable of maintaining a constant-current throughout this range with great accuracy.

In a paper read before the American Institute of Electrical Engineers January 3, 1902, by W. D. A. Ryan, the author draws the following conclusions as the result of a careful study of the various systems employed for the electric illumination of streets:—

"First. Open arcs give a higher maximum candle-power than do enclosed arcs of corresponding wattage, but the maximum candle-power is in an undesirable direction, and the light fluctuates through wide limits. Enclosed arcs give a higher candle-power through the most useful angle, from say 3 to 10 degrees below the horizontal. The light from the enclosed arc is more uniform and steadier, and generally superior from an illuminating point of view, to open arcs.

"Second. Direct-current enclosed arcs produce slightly higher candle-power than do alternating enclosed arcs of corresponding wattage, but so far as the illuminating value is concerned, the two lamps are on a fair basis of equality, both being superior to the direct-current open arc.

"Third. Small unit arcs will illuminate proportionately greater distances than will large units for a given expenditure of energy.

"Fourth. Incandescent lamps do not illuminate brilliantly to a sufficient height above the street surface to produce the effect of good lighting, and are therefore not comparable with arc lights."

Standards in Steam and Electric Locomotive Design

ELECTRICAL engineers are already making an effort to establish standards for electric locomotives, and to determine some definite factors which can safely be used in the design of such motors. In a work of this kind they have certain advantages over the designers of steam locomotives, according to "The Railway Age," and it may be interesting to point out some of them. While it may be too early to establish standards of construction for electric locomotives, yet some of the elements relating to their operation have been determined with such accuracy that it ought to be possible to accumulate with a short experience much of the essential data and determine factors and formulæ which would have rather general application.

In the operation of steam locomotives there are few conditions which remain constant, and for this reason it is difficult to predict a definite performance for a given design. With this type of motor the boiler is the principal element of uncertainty and the prime cause for limit in capacity. There appears to be a beneficent law which makes the rate of steam production increase with speed, and equal to steam consumption in passenger engines, but maximum power is seldom obtained at slow speeds with freight engines on account of the low rate of evaporation obtained with widely intermittent blasts of draft apparatus. Steam locomotive performance would be greatly improved in the amount of power developed if a constant maximum boiler pressure were assured and the volume of steam available was always greater than that which could be passed through the cylinders. With the electric locomotive, conditions equivalent to these are assured, and it is thus apparent how great must be the advantage of such a motor and how much more accurately its performance may be predicted.

The reciprocating steam engine is not best adapted to high speeds, while the rotary electric motor appears to be ideal for such service. The balancing of steam locomotives has until recently been a disturbing factor, which not only limited their speed and power but caused undue wear of both machinery and track. The most advantageous distribution of steam in the cylinders, and the proportion and setting of valves, are questions which have not been fully settled and no standard practice has been arrived at. Even such apparently simple matters as the proper diameter of drivers or the length of stroke of piston for certain conditions of trains and track have not yet been placed on such a definite basis as to cause any general agreement among the different roads in any country.

Motive power superintendents practically acknowledge that in a general sense there is no standard, nor any demand for standards, in locomotive practice, and it would seem as if some of the many types must be intrinsically poorer than others. Every lot of locomotives ordered has its design modified to suit ideas prevailing at the time, and numerous differences in details are sure to be introduced by the particular motive power superintendent who is in control at the time. The tendency toward standardization comes from the formation of great systems whereby one superintendent has a chance to put his ideas in practice in a large number of locomotives.

The greater part of the electric motors for traction purposes is supplied by two large electric companies, and their types are not very widely different, even in details of design. Each company has made about fifteen fundamental types of modern motors. Each of these has various combinations of the number of turns of wire per slot, feed turns, gear ratios, current, electromotive force, etc. In consequence about seventy-five different motors are available to the electrical engineer for traction cars or locomotives. Some of these have no counterpart in steam locomotive design. Comparing the motor with the locomotive, we have the armature corresponding to the cylinders, and the combination of gears to the driving wheels. The locomotive designer determines the diameter of drivers on the basis of tractive effort and acceleration only, while the electrical engineer must consider heating effects,—a phase of the traction problem unknown to the designer of the steam locomotive.

The author believes that there is too great a variety of gear ratios in electric motors, and some effort should be made to standardize the few ratios which are most essential. The electrical engineer has the great advantage of being able to test the motor unit and obtain its characteristics in the shop before it is assembled in the main structure on drivers. With the steam locomotive all the uncertainties of boiler and cylinder performance remain until the structure is completely assembled and tested on the track. The performance of an electric locomotive should therefore be predicted with greater certainty than one operated by steam, and the possibility of maintaining a few standards and avoiding the multiplicity of designs which have been made for steam locomotives should be the hope and aim of those who are directing this great industry which is so rapidly developing.

On the Berlin-Dresden wireless telegraph line a working periodicity of 900,000 has been adopted. From the station at Oberschönlweide good readable messages have been sent not only to Dresden, 110 miles, but also to the lighthouse station at Fehmern, in Holstein, 166 miles northwest, and Carlscrona, in Sweden, 281 miles north. At Dresden during the night hours signals have been read that originated at the Marconi station at Poldhu, a distance of 764 miles. The wave length of the undulations from the latter station has been determined to be about 2000 m., or 1¼ miles.

Electric Heating

Its History and Development

By A. E. JEPSON

Abstract of Paper Read Before the Manchester Students' Section of the British Institution of Electrical Engineers. To this several illustrations of modern electric-heating apparatus have been added, not provided in the original paper.—The Editor.

A PROMETHEUS HEATER

THE use of electricity for producing heat, and the application thereof, is by no means the novelty that it is popularly supposed to be. As early as 1815 there was an account published in the "Philosophical Magazine" of a paper contributed by Pepys, in which he related some experiments conducted by him with electrically-produced heat. He made a saw-cut in a piece of iron wire, into which he placed some diamond powder, and then covered the whole with an insulating powder, in order to confine the heat as much as possible. After subjecting the wire for a period of six minutes to a current sufficiently strong to raise it to a bright red-heat he allowed it to cool, and found that the wire adjacent to the saw-cut was converted into steel.

In 1827 Sir Wm. Harris gave an account of some experiments conducted by him on the heating of air in closed vessels by platinum wires. It was not, however, until 1841 that Joule discovered the law known by his name.

One of the first applications of this heating effect to commercial uses was made by Napier in 1844, when he patented an appliance for reducing metals.

Depretz, in 1849, described a small apparatus which consisted of a tube of sugar charcoal with a core $\frac{1}{4}$ inch in diameter, the total length being about 1 inch. The two ends were plugged with pieces of the same material, and a heavy current passed through, which brought the whole to a white heat.

As early as 1862 Monckton patented a furnace for reducing carbon and alumina, but owing to the scarcity of power and its excessive price at the time, it was not a commercial success.

Again in 1880 Borchers succeeded in reducing oxides which up till that time were believed to be irreducible, but the method was not greatly improved upon for some time, chiefly owing to the high price of current.

In Hospitalier's "Domestic Electricity," published in 1885, accounts and illustrations are given of various oil and spirit lamps which were ignited by bringing a red-hot platinum wire over the wick, current being supplied from primary batteries.

The year 1887 saw the patenting and application of the Héroult process of obtaining aluminium from alumina, using cryolite as a flux, and in 1894 the carbide industry came to be worked on a commercial scale, although the product had been known to chemists since the middle of the nineteenth century.

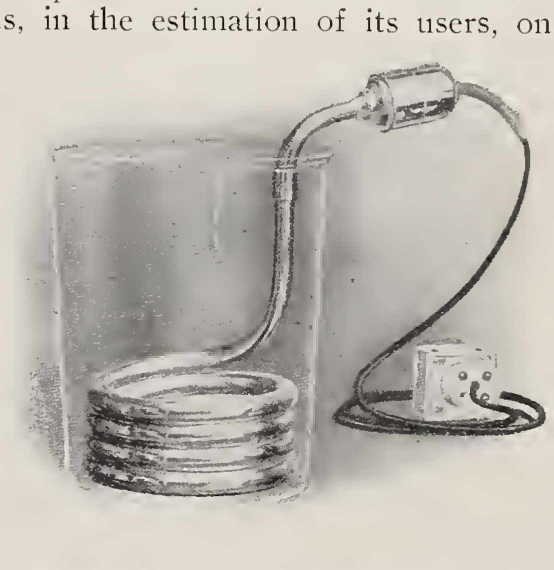
Within the last ten or twelve years great improvements have been made, though even now the commercial articles are far from standardization. In some instances, 98 per cent. of the energy expended is usefully applied, and the only direction in which further improvement is possible is in the speed of operation and in adaptability, but there are many operations, such as cooking, which cannot be performed in less time.

It is obvious that no one heating element or unit is universally applicable to all operations. The following important qualifications are, however, necessary in all cases:—First, the operation must be performed as quickly as possible, the speed being governed by the nature of it; secondly, at the highest efficiency, and therefore at lowest cost; thirdly, there shall be no smell or dirt.

As regards the first, the time limit is fixed not only by the nature of the operation, but by the fact that if heat is produced more quickly than it can be carried away by conduction, convection and radiation, the temperature of the heater would become so excessive that the resistance would fuse.

The second condition naturally varies with the nature and time of the operation, the higher efficiencies of 80 to 98 per cent. generally being due to the fact that the appliances have self-contained heaters, the lower efficiencies of 50 per cent. or under being obtained when the heat has to be transmitted between two more or less uneven surfaces, such as a pan of water on a hot plate.

The third is rather an important consideration, since, in these days of improved sanitary and hygienic conditions, any cooking or similar process that is only possible with an accompaniment of dirt and evil smells is, in the estimation of its users, on



AN ELECTRIC IMMERSION HEATER MADE BY THE AMERICAN ELECTRICAL HEATER COMPANY, DETROIT, MICH. COILS OF THIS KIND ARE SPECIALLY ADAPTED FOR HEATING WATER, OR OTHER LIQUIDS IN TANKS OR VESSELS, AND FOR THIS PURPOSE ARE TO BE PREFERRED TO DISC HEATERS OR HOT PLATES, BECAUSE THEY ARE NOT ONLY MUCH QUICKER IN ACTION, BUT ARE ALSO MORE ECONOMICAL AND DESIRABLE IN OTHER RESPECTS

a level of one in which coal, coke or gas is used.

One of the chief arguments against the use of electricity for heating purposes it is great cost, and one is constantly being reminded, when discussing the subject, of the price of current and the amount required for the various operations. There is no doubt that at present the price is rather high for general household use, but

A GROUP OF ELECTRIC HEATING APPLIANCES MADE BY THE SIMPLEX ELECTRIC HEATING COMPANY, CAMBRIDGE, MASS. BEGINNING AT THE LEFT THEY COMPRISE A NURSERY MILK WARMER, TRAVELER'S STOVE, CHAFING DISH, HOT-WATER CUPS, COFFEE URN, COFFEE PERCOLATORS, TEA KETTLE AND ANOTHER CHAFING DISH

if electric power were used universally for heating purposes the load factors of the supply stations would materially increase, for the reason that the times at which meals are cooked occur, during the greater part of the year, on either side of the peak load. If we allow, then, that the apparatus have reached their highest efficiency, it is clear that the first cost of apparatus and the price of current must be greatly reduced before their adoption for general use can be increased. To illustrate its possibilities with cheap power, a rather interesting case is that of Davos Platz, in Switzerland, a town having a total of about 5000 inhabitants. Power is obtained from neighbouring waterfalls, from which 15,000 H. P. is available, and with this the total lighting and heating of the town is effected, the cost per kilowatt-hour being one-third of a penny.

One of the chief determining factors of the price per kilowatt-hour is the cost of labour, a quantity which, judging from the present outlook, seems capable of very slight reduction. Another more serious factor is the conversion efficiency from pounds of coal to kilowatt-hours, which may be taken at about 10.15 per cent. Taking the efficiency of the dynamo and switchgear at about 75 per cent., we have the total efficiency of the conversion from coal to electric heater as 7.6 per cent. It must be admitted that this is a very poor efficiency, but it is quite possible that in the near future it may be considerably increased. Compared with gas, however, the disparity does not appear so great, as will be seen from the following figures :—

When burnt under suitable conditions, 1 cubic foot of gas is capable of rendering 170,000 calories. A gas range is credited with an efficiency of about 15 per cent., so that 1000 cubic feet of gas burnt in a range would give 25,500,000 effective calories. Allowing that 1-KW.-hour of electricity = 857,143 calories, and the efficiency of an electric heater as 85 per cent., then the effective calories would equal 728,572. Therefore the proportion between the effective calorific values of 1000 cubic feet of gas and 1-KW.-hour of electricty is about 35 : 1.

According to this, with gas at the present price of 2s. 4d. per 1000 cubic feet in Manchester, apart from all other considerations, electricity will have to be sold at 0.8d. per unit for heating purposes. Although this ratio of costs does not always hold good, it will be found to be a fair average value.

It will now perhaps be advisable to consider the various systems in use at the present time, and to investigate as to how nearly they fulfil the ideal conditions of heating.

We are all more or less familiar with the ordinary carbon filament electric lamp, and although it is regarded as being primarily a source of

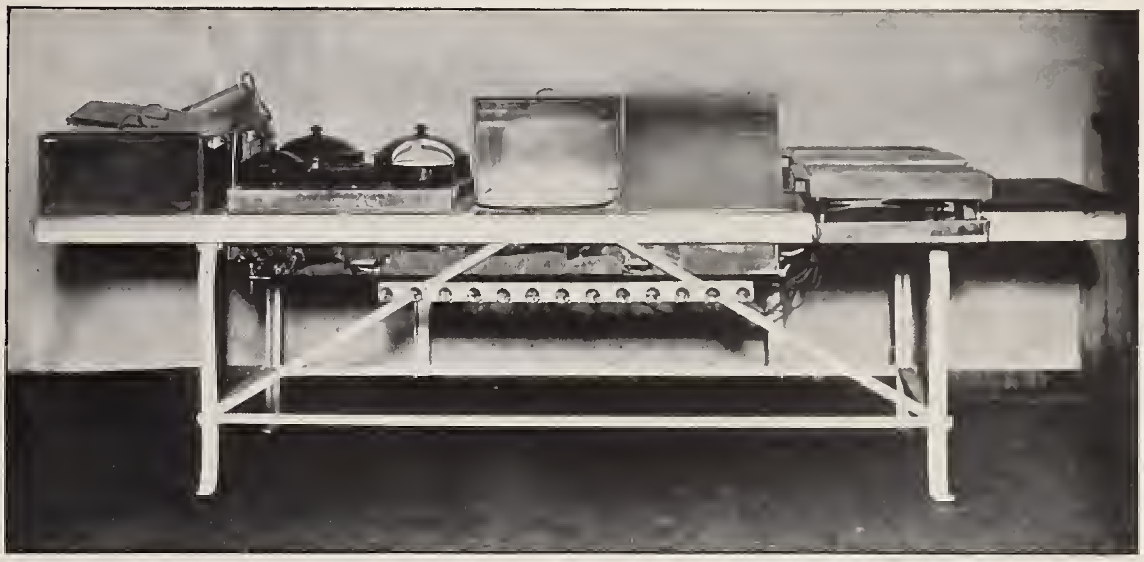
light, yet only 3 to 5 per cent. of its energy is converted into light, the rest being spent in heating up the filament to the temperature sufficient to cause it to emit the luminous rays. In the first types of electric heaters the heat given out by these lamps was used, a lamp sometimes being fixed on a stand so that the water vessel, which had a recess in the bottom, could be placed over it. This method has, however, been found to be impracticable, and it has consequently been almost, if not entirely, abandoned.

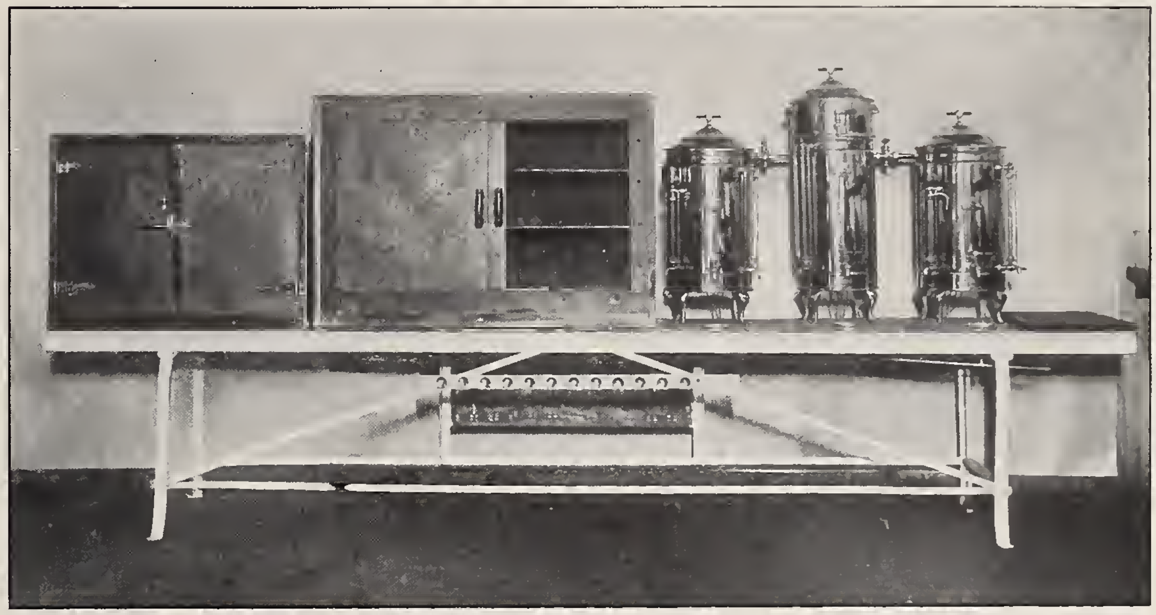
In some of the later forms of apparatus, coils or resistance wire, packed in powders of various compositions, were tried, but these also are not now used to any great extent. A further advance of some importance was made by fixing the wire in close proximity to the heating surface by means of asbestos powder mixed with silicate of soda. Usually water vessels had a false bottom, to allow for the space taken up by the pasted wire, and also to allow for pocking underneath. The packings which are used at the present day are powders of gray and white asbestos, ponderous calc. magnesia, silica, glass, Calais sand, and cotton silicate. The chief reasons for discontinuing the use of asbestos paste are that it has a low resistance when cold, due partly to its being hygroscopic, and that it is a bad conductor of heat.

For the last few years attention has been directed to the use of enamel similar to that used very largely for permanent signs and enamelled ironware. This enamel has been found superior in many ways to most of the insulators which will stand high temperatures without melting or igniting. The enamel comprises two parts, the ground mass and the surface, which is the enamel proper. The ground mass may consist of silica (in the form of white sand or powder), crystallized borax (for fluxing), flourspar and magnesium carbonate (which reduces fusibility). These are mixed in varying proportions, powdered and fused, then again reduced to a powder, and to this is added aluminium silicate (in the form of pipe-clay) and pure powdered quartz.

The enamel proper consists of flint meal (which is composed of quartz and silicates of iron and aluminium), also tin oxide, saltpetre, ammonium carbonate, lead sulphate, magnesium sulphate, potassium carbonate, borax, and sometimes gypsum and arsenic. These are mixed in carefully proportioned quantities as too much of one will make the enamel crack off, and too much of others will make the fusion point too high or too low. A great deal of experience is necessary to get a satisfactory enamel combining the right qualities and also good insulating properties at temperatures within reasonable limits. The insulation resistance varies enormously with temperature, in some cases being 40 megohms when cold, but dropping to a large current went by way of the frame and enamel that the latter fused, setting up an arc between the wire and frame.

There are many reasons for using enamel on iron, the most important of which is the very slight disparity between the expansion coefficients of





AN ELECTRIC KITCHEN OUTFIT, INSTALLED FOR THE NIAGARA CONSTRUCTION COMPANY, LTD., OF NIAGARA FALLS, BY THE PROMETHEUS ELECTRIC COMPANY, OF NEW YORK. IT CONSISTS OF TWO ANGLE-IRON TABLES, 10 AND 12 FEET LONG, RESPECTIVELY, ON WHICH ARE MOUNTED 5-GALLON URNS, FOR MILK, COFFEE AND HOT WATER; AN OVEN LARGE ENOUGH FOR A 25-POUND ROAST; TWO LARGE COPPER VESSELS FOR BOILING MEATS; BROILERS, PLATE WARMERS, ETC. CURRENT CONSUMPTION 27 KW.

about 1000 ohms at 400 degrees C. Most of the enamels melt at about 900 degrees C.

Some of the early enamels were of a composition closely resembling glass, and when a fair temperature was reached this melted, allowing the wire resistance to float about the surface of the metal base, until the connections, which were the heaviest parts, sank, and so short circuited on the base. Other enamels, when subjected to a moderate temperature, cracked and lifted off, and there being nothing to carry away the rapidly generated heat, the wire fused. In other cases where the insulation resistance was very low when hot, such

iron and enamel, whereas between that of copper and most of the other metals and enamel it is very much greater. The expansion coefficient for 1 degree C. for cast iron is 0.000010, for sheet iron 0.000011, and that for enamel 0.000009, but that of copper is 0.000017. This, then, shows that it is best to use cast iron together with enamel, as the difference between their coefficients is so slight, being only 0.000001, although the insulation resistance of similar enamels is found to be better on wrought iron than cast.

In some types of heaters the ground enamel is laid next to the heating surface, the resistance wire being

then laid on this in the correct position, and finally the surface enamel is fired on. In order to get a long length of wire into the small area of the heater, the wire is crimped, and lugs are fixed to the ends to which connection can be made easily when the wire is embedded. In many cases when using this type for water utensils, the heater is made into the form of a cast or wrought-iron disc, which is then soldered on to the bottom of the vessel, a good heat-conducting surface being ensured by heating the disc (by means of a current being sent through it) to a temperature sufficient to float it in the solder melted on the inverted bottom.

In another type of heater only a ground enamel is used, but this is of a much finer composition than the previous one, the metallic resistance being composed of a very thin film of platinum, which is laid on the enamel surface. Under the same patents of the "Prometheus" Company a form of heating unit is made which is specially suitable for articles requiring temperatures up to 450 degrees C. These heating units are composed of strips of mica about $\frac{4}{1000}$ of an inch thick, on which is painted a film of gold or platinum, sometimes only $\frac{4}{4500}$ of a millimetre thick, being, at this thickness, quite transparent. The metals in the form of powders are mixed with a flux and then painted on the mica, after which the whole is subjected to a high temperature, the finished films sometimes being produced of 100,000 ohms resistance, each being made to consume not more than 70 watts, this giving a temperature of about 450 degrees C. To prevent injury to the film it is covered with another strip of mica, and then totally or partly enclosed in a thin metal frame.

The insulation resistance of these strips is from 50 to 300 megohms, and the increase in the resistance of the foil varies from 10 to 20 per cent. during a period varying from 1 to 8 minutes. When used for warming rooms, these heating units are fixed in a metal framework which connects them in parallel, so that if one breaks down the others will still continue to be in circuit.

AN ELECTRIC RADIATOR MADE BY THE PROMETHEUS ELECTRIC COMPANY, NEW YORK

For water vessels, long units are bent into a circular form and the two ends are fastened together by means of screws and nuts which serve to hold them in position and make good heat contact between them and the sides of the vessel. For such articles as hot plates, flatirons, etc., the heaters are pressed by means of screws and asbestos pads on to the heating surface.

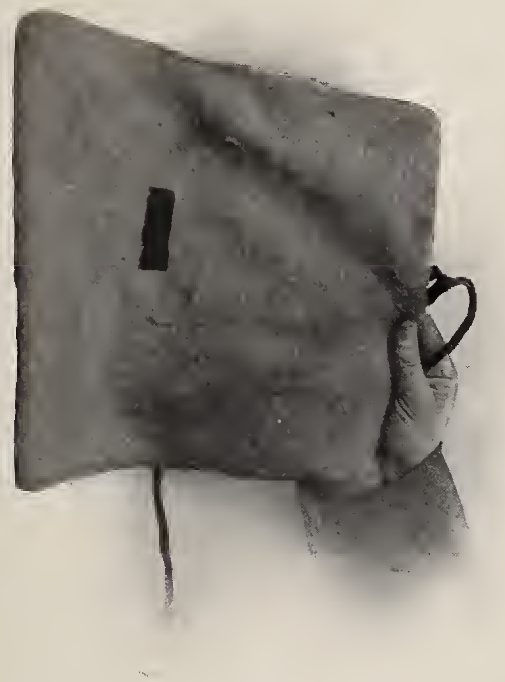
In the Parvilée and Le Roy systems a very different heater is used. These heaters are either composed of a mixture of silicates and metals, cast into bars, or of bars of agglomerate silicon. The former are usually exposed to the air, while the latter are enclosed in glass bulbs with the air exhausted from them. These bars of metallo-ceramic composition can be made of any desired resistance, and to ensure good electrical contact, brass springs, which take up the expansion, are brazed on to the ends. Each bar is about 7 inches by $\frac{1}{2}$ inch by $\frac{1}{8}$ inch, and is made to consume from 400 to 500 watts, attaining a cherry-red heat. This appears to be an ideal system in many respects for certain classes of work. For warming rooms the bars can be fixed in suitable frames, so that they will be open to the air, emitting a cheerful glow like that of an ordinary fire. For grilling they can be fixed in a vertical or horizontal position either above or below the food, as the heat is both radiated and convected. When used in stoves for boiling liquids, the bars are placed in porcelain containing vessels which reflect the heat upwards to the bottoms of the pans or kettles, which are fitted with recesses in the top to allow the heat to be well absorbed by them.

In the Schindler-Jenny system the resistance, usually composed of wire, foil, or tape, is formed into the required shape and covered with porcelain clay, after which it is fired in a furnace, and then round the whole is cast a metallic shell of aluminium, copper, or bronze, which makes the whole a mechanically strong homogeneous mass. The units are made into various shapes according to requirements. For some radiators or convectors they are made flat with or without ribs, and for others they are made in a circular form with ribs on the circumference, connection being made to the resistance by three contact pins projecting through three holes in the shell.

The proportion of the amount of electrical energy which is sent into the various appliances to that which is usefully applied in the form of heat of course varies in the four systems above described, but it can be said that very high efficiencies can be ob-

tained when using the most suitable methods. Radiators and convectors, of course, have 100 per cent. efficiency, as all the heat which is generated is finally spent in warming up the air. For flatirons the efficiency cannot, of course, be given, as the amount of heat usefully employed cannot be measured, but for water utensils good results can be obtained.

The following are the actual figures obtained by tests on a one-pint and a two-pint kettle:—A two-pint single-jacket kettle containing two pints of water at 16.6 degrees C. took exactly 9 minutes to boil, with a consumption of 792 watts. The amount of heat actually required to boil this 11.36 grammes of water would be 94,663 gramme-degree-calories, but the amount actually used for the operation was 102,500, the total effi-



AN ELECTRIC WARMING PAD MADE BY THE SIMPLEX ELECTRIC HEATING COMPANY, CAMBRIDGE, MASS. THE ELECTRIC WARMING PAD IS DESIGNED TO TAKE THE PLACE OF THE ORDINARY CUMBERSOME HOT-WATER BOTTLE. IT CONSISTS OF AN ELECTRIC HEATING ELEMENT, WITH AN OUTER CASING OF EIDERDOWN OR RUBBER CLOTH, THE OUTER CASING BEING REMOVABLE AND WASHABLE, SO THAT THE PAD MAY ALWAYS BE KEPT IN A SANITARY CONDITION

ciency being 92.25 per cent. The one-pint single-jacket kettle contained 600 grammes of water at 13 degrees C., the boiling operation taking 7 minutes 7 seconds, with a consumption of 561 watts. The amount of heat actually required to boil this water would be 52,200 calories, but the amount actually used was 59,651, the total efficiency being 87.5 per cent. This lower efficiency is mainly due to the greater proportional radiation surface of a one-pint kettle.

If a number of such operations follow closely upon one another, the heat latent in the metal after the first operation is added to the next, increasing the efficiency to 95 per cent. or more. A consumption of from 40 to 50 watts per square inch is usually allowed for the heaters used in water vessels, although only about 5 are allowed to keep them hot, or nearly boiling. The efficiency can be increased by having double jackets to all the vessels, and also by keeping them highly polished, this making a difference of about 3 to 4 per cent.

If these water vessels are left in circuit while empty, the temperature of the disc rises to such a high value that the solder which fastens it to the bottom melts, allowing it to fall off, and so the temperature rises still higher, and finally fuses the wire and enamel. This difficulty is now entirely overcome in some of the vessels by having a fusible cut-out in circuit, of which the following is a general description:—In the center of the heating disc (Fig. 1) is riveted a copper pin which has a collar in the middle with its face flush with that of the disc. The end of this pin *T*, which is on the enamelled side of the disc, is screwed to allow a cylindrical nut *N*, made of cadmium, lead, and tin, to be screwed over it, into the other end of which a contact bridge *C* is screwed.

This bridge mainly consists of an insulated copper washer forming a connection between two springs, through which the current has to pass in order to complete its circuit.

When the vessel is put on circuit while empty, the disc rises above its normal working temperature, and the heat is then conducted down the screwed copper pin to the fusible nut, which melts just above 100 degrees C., allowing the bridge to fall into a brass cup provided for the purpose, and so breaking the circuit. The circuit is easily established again by screwing a new nut into position. To protect the discs and connections, and also to keep as much heat in as possible, a false bottom is soldered on, to which the feet are attached.

In many cases it is of course necessary to vary the heat given out by the apparatus, and this may be done by cutting out some of the circuits which are in parallel or by putting a resistance in circuit with the heater, which may be self-contained or external. The circuit changing may be effected by a many-contact resistance switch, by a number of plugs, or by one plug and many positions. Generally four heats in the proportion of 1 : 2 : 3 : 4 are quite sufficient, and may be obtained with two circuits only, one being of a comparatively low resistance and the other about twice as great. For the lowest heat the two circuits are in series; for second heat the high resistance only; for third heat the low resistance only, and for the highest heat the two circuits are in parallel. These different changes can be effected by one plug and socket. The resistances should be so disposed that the watt consumption per square inch of heater when on full heat is about the same

A MODERN ELECTRIC BROILER MADE BY THE AMERICAN ELECTRICAL HEATER COMPANY, DETROIT, MICH. A MEDIUM-SIZED STEAK CAN BE COOKED WITH THIS DEVICE AT A COST OF TWO CENTS

all over the heating surface, and for this reason the circuits have sometimes to be divided into a number of parts.

Convectors or stoves for warming rooms, corridors, churches, offices and cars are made in a variety of patterns, and in the case of the enamel system the convection area is increased by having artistic projections cast on the surface. For room warming 1 to 4 watts per cubic yard per degree centigrade above the surrounding atmosphere are usually allowed,

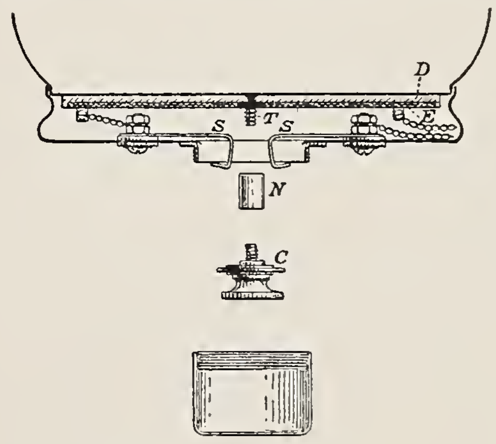


FIG. 1

depending upon the height of the room and the number of people using it. The heating of cars, however, must be taken on a separate basis altogether, as the air rapidly changes, owing to the draughts carrying the heat away from the interior. Experts usually allow about 50 watts per person.

According to varying conditions, regulation of the heaters is required,

and this is sometimes performed by putting them in parallel or series. When heaters are used which are made up of a number of resistance spirals supported on porcelain insulators, they should not be placed where water dripping from the passengers' clothing can drop on the wires, as they quickly deteriorate under these conditions. Sometimes the convectors are placed in the bottom of the car, so that the air will be warmed in its passage through them. About 6 watts per square inch are usually allowed for the enamel type of convector, but those using metallic films on mica need rather more than this. According to a paper read by J. T. McElroy before the Street Railway Association of New York, for car heating, about 10 to 20 per cent. of the energy required for running is spent in the heaters, and the average of tests taken upon American cars with coal and electric heaters for 15-hour runs gave the price per day of 15 hours for coal as 9½d., and for electricity 9d.

At present, for room and office warming, luminous radiators are very much in vogue, as no doubt the cheerful glow given out by them is as comforting as their actual warmth.* The heating effect of these radiators is produced by the current flowing through a carbon filament 13 inches long and 1-16 inch diameter, which raises it to a bright red heat. The filament, which is contained in an exhausted glass bulb about 8½ to 10 inches long, is bent in the middle to form a single loop, the ends being like an ordinary lamp connected to a bayonet cap or Edison socket. Each lamp is made to consume about 300 watts, and with from 1 to 5 lamps in each radiator very pretty effects can be obtained. Owing to the comparatively large currents which the contacts are required to carry, they are usually made of rolls of copper gauze with the ends left rough so that they will bed well.

* One form of such radiators is shown on page 380 of this issue.

If an iron of the enamel type which has been wired for a rather high watt consumption is left on circuit for any length of time without being used, it is liable to heat up to such an extent that its life is seriously impaired. To counteract this an ingenious contrivance has been invented which cuts off the current if the operator does not put it on the stand which is intended for it, or if he does put it on the stand, by means of a switch in the top of the latter, a resistance is put in circuit with it which reduces the current to about one-half. To prevent as little loss as possible the series resistance is wired in the stand. The contrivance which switches off the current when the iron is put out of the operator's hands reduces fire risks to a minimum. Irons are made in a variety of patterns, the weights varying from ½ to 25 pounds, and from 20 to 25 watts per square inch of ironing surface being allowed. In some cases the ironing blocks used by hatters, tailors and embossers are also heated electrically.

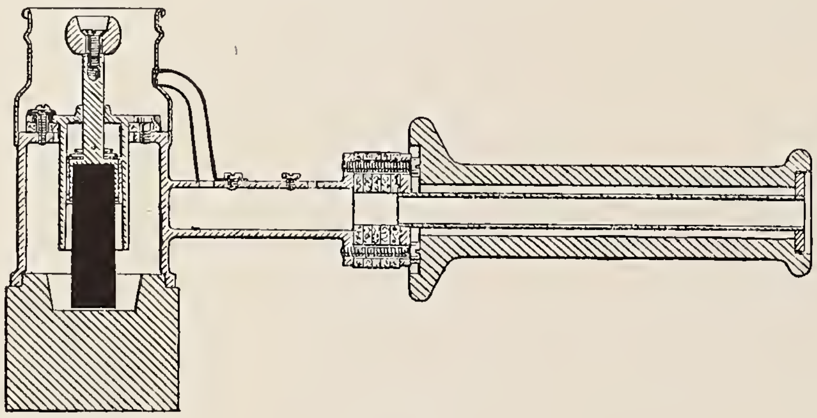


FIG. 2

One of the most important articles for domestic use is the electric oven, which is capable of very large development. The most important types of ovens employ either hot plates of special design, metalloceramic bars or wires wound on porcelain tubes to dissipate the heat. A rather ingenious oven is constructed in a circular form, made so that it can be rotated about the central support. On this support are constructed a number of circular shelves divided into segments, each segment being controlled by a separate switch and heater, and in some cases there is an upper as well as a lower heater, so that the former can be lowered near to the food. The object of having this construction is so that a large or small quantity of food can be cooked at one operation, and can be more easily examined by bringing each segment before the main door.

Another important method of electric heating is by means of the arc, which is largely used in many commercial processes. It is applied to a few domestic appliances, such as electric flatirons and radiators. For packing-case makers and canning factories soldering irons are made which are heated by the arc in their interior, which plays between a carbon rod and the large copper bit (Fig. 2).

Professor Ougrimoff, of Moscow, has designed a large water heater of 98 per cent. efficiency. This heater consists of a crucible of cast iron, in the bottom of which is placed powdered graphite. In this crucible, and regulated by a wheel and screw, is a large carbon rod which forms the positive pole, the crucible being connected to the negative pole, so that when the arc is set up the greater heat is produced on the graphite surface, and short circuits are prevented by the resistance of the graphite. The heating chamber, which chiefly consists of the crucible, is, with the exception of the top, surrounded by the water to be heated, thereby preventing much loss.

The arc is also used in various types of furnaces for metallurgical work. In the Bernados and Zerener processes the arc is used for filling up with metal the blow holes which appear in iron castings, also for welding the seams of tubes and plates. For experimental purposes temperatures up to 2000 degrees C. have been obtained by passing a strong current through a tube of iridium, raising it to a white heat.

A type of furnace has been lately developed which derives its heat from the large currents produced in any metal by a fluctuating magnetic field, the lines of force of which are made to cross the metal. The crucible is made in a circular trough form, into which is poured some molten metal, thus forming a ring over which is piled the ore or metal to be treated. After a certain time has elapsed the ring melts and attains such a temperature that ores above it soon melt.

Another method of raising bars of metal to a welding temperature is to dip them into a lead-lined tank containing an aqueous solution, such as potassium carbonate or borax. The heat caused by the current through the high resistance film of hydrogen evolved at the positive pole, to which the rod of iron is connected, soon raises it to a temperature sufficient to melt the metal and cause it to run off from the end of the bar.

In conclusion it may be said that heating by electricity has certainly proved itself superior in most respects to any other method of heating, its chief drawback at present being the cost of electrical energy, which will satisfactorily decrease as the number

of consumers increases, a state of affairs which could be more quickly brought about if more interest was taken in this branch of the industry.

There is certainly a good opportunity for the electrical departments of corporations to open establishments for the loan of electric heating and cooking apparatus similar to those of the gas departments of some of our large cities, special reductions being made for summer loads.

The Electric Furnace in Steel Making

IN a recent issue of the Engineering Supplement of the "London Times," F. W. Harbord writes of the place the electric furnace may be expected to take in the British steel industry. Already one electric furnace has been operated at a Sheffield steel works, and it is reported that another Sheffield company has acquired the exclusive patent rights of the Héroult process for Great Britain. We quote from the article as follows:—

"While on the one hand the extravagant claims urged on behalf of electric smelting—that it will revolutionize the manufacture of structural steels as at present made by the Bessemer and open-hearth process—may be dismissed as nonsense, the attempts on the other hand to prove that it cannot compete with the crucible process in the manufacture of tool steels or the open-hearth furnace for many of the higher class steels intermediate between these and common structural steel may equally be disregarded. The truth lies between these two extremes, and the manufacturer who realizes this and takes advantage of the great possibilities which the electric furnace offers to meet very many of the special steel requirements of to-day, and who does so with judgment and knowledge will, without doubt, be in a most exceptional position, not only to meet foreign competition, but to more than hold his own against his British competitors.

"Since the Canadian Commission visited Europe last year, rather more than a year has elapsed. During this time very considerable quantities of electric steel have been made both in Sweden and in France, and have been used with most satisfactory results for all classes of tools and cutlery, and for various other purposes for which the highest class crucible steel was formerly employed, confirming in every way the conclusions of the commission that 'steel equal in all respects to the best Sheffield crucible steel can be made.' Considerable quantities of this steel have been supplied to Sheffield firms who have thus been able to convince themselves of its exceptionally high quality, and it now only remains for our Sheffield people to make the steel for themselves rather than import it. The manufacture of crucible steel for tool purposes, important as it is to the country, owing to the world-wide reputation for quality which it has acquired, is, however, only one comparatively small branch of our great steel industry, and perhaps the most important question is to what extent electric smelting can be employed for the manufacture of the numerous classes of steels between this and ordinary Bessemer or open-hearth steel.

A LARGE FIELD FOR THE ELECTRIC FURNACE

"We import annually very large quantities of Swedish Bessemer steel for tube blanks for the solid-drawn tube trade, and for other purposes too numerous to mention; again, large quantities of Swedish pig irons are imported for use in our open-hearth furnaces for the manufacture of special qualities of high class steel for large forgings, axles, tires, special wire and other purposes, and in many cases steel of the required composition can only be made by using, either entirely or in part, these very high priced pig irons. Another very important branch of the steel trade is the production of dynamo steel of exceptional purity and low hysteresis, and in this direction the electric furnace promises great things, as steel of the greatest purity, low in carbon and manganese, can readily be produced. If we add to these the manufacture of all kinds of ordnance, armor plate, projectiles, rifle, bayonet and other high class steel, we see that without attempting to compete with Bessemer or ordinary open-hearth structural steel, there is an immense field open to the electric furnace. Numerous experiments have shown that electric steel is not only extremely pure, but it is also exceptionally homogeneous, and this is a most important point in the manufacture of large steel castings. When it is remembered that for special purposes castings, sometimes of 50 to 60 tons, have to be made by mixing the contents of a number of crucibles not containing more than 1 hundredweight each, the advantages of being able to make steel equal in all respects as to quality, in quantities of 15 tons and possibly more, will readily be apparent.

"If steel to satisfy the exacting requirements of the highest class of tool steel can be produced, there can be no question as to the production of steel of a quality suitable for what we may term medium class steels, and it then becomes simply a question of cost, and whether the electric furnace can compete in this respect with Swedish Bessemer steel, or steel made from Swedish pig iron or steel of specially selected English brands.

"In the electric furnace of the resistance type, which may be said to be represented by the Héroult and Keller furnaces, the highest class steel can be made from ordinary English scrap, such as rail ends, but against the saving effected in this direction has to be set the cost of the electric energy required. The electric furnace, even under the best conditions, is not a cheap melter, but as a refining furnace toward the end of the operation, when a very high temperature is required, it is far more efficient; it therefore seems probable that the future development of the electric furnace will be in combination with some form of continuous open-hearth process in which molten pig iron is first converted into what we may term 'molten scrap steel,' in a gas-fired furnace and then transferred in the molten state to the electric furnace for final purification. By this means the additional cost over ordinary open-hearth steel would be comparatively small, the melting and preliminary refining having been done in the gas-fired furnace, and the electric furnace being employed only to do the final refining at such high temperatures as those at which it alone is able to work most efficiently and economically.

HEROULT, STASSANO AND KJELLIN FURNACES

"The design of the Héroult furnace, so far as the general construction is concerned, is particularly well adopted to work in combination with an open-hearth tilting furnace, and if, instead of charging cold scrap or even molten pig iron, converted metal were charged on some such lines as suggested, a steel superior to best Swedish steel, or steel made from Swedish pig iron, should be obtained at a less cost. Given a

large output so that labour costs are reduced to a minimum, the price at which such a steel could be produced would no doubt induce many manufacturers to employ it for purposes for which at present they are content to use inferior steel; and thus it would soon create a demand for high-class material apart from that already existing. It is not suggested that a simple refining of ordinary steel in this way would be sufficient for the production of the highest class of tool steels. For the production of these it would no doubt be necessary to carry on the operation in the electric furnace in a way similar to that employed at La Praz, at a considerably greater cost as to expenditure of electric energy, time and labour; but in these cases the process is not competing with the open-hearth method, but with the crucible process, in which, although the output may be comparatively small, there is a much greater margin as regards cost of production, and the question of a pound or so a ton is of no great consequence.

"There are two other types, the induction furnace and the arc furnace, which are now competing with the resistance furnace for the favour of the English steel maker. The former is represented by the Kjellin furnace, which has been at work for several years in Sweden, and the latter by the Stassano furnace, which has been at work for a considerable time in Italy. The Kjellin furnace is quite distinct both in principle and construction from the Héroult furnace, while the difference between the principle of the latter and arc furnaces generally is not so clearly marked, and they merge one into the other. In general arrangement, and also as regards electrical and other details, the Stassano furnace is totally distinct from the Héroult, and it was primarily designed for the direct smelting of iron ore rather than for steel making, although it has been producing steel most satisfactorily for some time. From a practical engineering and metallurgical standpoint, however, there can be no doubt that the Héroult furnace is far better designed to meet the general requirements of the steel manufacturer than either the Stassano or the Kjellin furnace.

"It is understood that a furnace of the latter type is already at work in Sheffield, and there can be no question as to the quality of the steel produced, provided high-class material, such as Wallon scrap, is used for its production. In Sweden, where a furnace is attached to works producing this high-class scrap, probably this furnace is as good and may under such conditions be even better than the Héroult; but the objection to it under English conditions is its lack of adaptability both as regards the materials which can be used, and by any variation in design to suit the conditions of our practice. In reality it is a large melting crucible, and to get the highest class of steel it is necessary, just as in the crucible process, to charge the purest materials, as the amount of purification which takes place during the operation is practically very small. On the other hand the Héroult process can deal with ordinary English scrap or pig iron, and by the repeated addition of suitable fluxes to form new slags the impurities can be removed so that a final product is obtained equal, if not superior, to much that is made from Swedish materials in a crucible.

SUPERIOR PROPERTIES OF ELECTRIC STEEL

"That steel made in an electric furnace should possess superior properties to steel of similar composition produced either in a Swedish Bessemer converter or in an open-hearth steel furnace may seem at first to be claiming a great deal, but such appears to be undoubtedly the fact, and this is due probably to its production in what may be regarded as a practically neutral atmosphere, under conditions in which the occlusion of gases and overoxidation are reduced to a minimum.

"It is frequently urged that the cost of electric energy in this country makes the production of steel in anything like quantities a commercial impossibility; but with electric energy at £10 per kilowatt-year, at which price it can be produced under favourable conditions from coal, and by using the gas furnace for the melting, and the electric furnace only for the final operation, the difference in cost as regards electric energy will probably be more than met by the lower price of our raw material and our proximity to markets for the sale of the finished product. When the irregularity in supply due to the change of seasons and the generally inaccessible position and remoteness from sources of supply, and from markets for the sale of the finished product are taken into consideration, the much talked of cheap production of electric energy from water power will often be found to be more apparent than real."

Further particulars of electric furnace applications may be found in THE ELECTRICAL AGE for June, 1904, and April, 1905.

The Zinc Mining Industry

According to the United States Geological Survey Report on zinc, by Charles Kirchhoff, the production of spelter in the United States in 1904 amounted to 186,702 short tons, valued at $18,670,200, as compared with a production of 159,219 tons in 1903. The principal increase in the production of zinc has taken place in Kansas, where new plants were started by the Caney Zinc Company at Caney; by the Chanute Zinc Company at Chanute; and by the Cockerill Zinc Company at Altoona. The La Harpe Smelting Company at La Harpe, which started in 1903, had a full year's production. The plant of the Granby Mining & Smelting Company was enlarged. The large works of the Edgar Zinc Company at Cherryvale, controlled by the United States Steel Corporation, reached their full product in 1904.

In Illinois the Illinois Zinc Company built an addition of 120 retorts; and the Mineral Point Zinc Company, controlled by the New Jersey Zinc Company, is building large new works at Depue. During 1904 the new works of the Graselli Chemical Company, of Cleveland, were started at Clarksville, W. Va. The United States Zinc Company at Pueblo, Col., which is owned by the American Smelting & Refining Company, has put up two additional furnaces, thus increasing the capacity by 25 per cent.

The production of Missouri was restored to its former place by the resumption of the operations of the Nevada plant by A. B. Cockerill. The Sandoval works have made a larger product, while the Indiana plants were idle altogether.

The production of zinc ore was also stimulated by various causes in the Missouri-Kansas district, in the Rocky Mountain regions, in Wisconsin, Kentucky, Virginia, and Tennessee.

In these days of electric power, it seems strange, says the "Bulletin" of the New York Edison Company, that the several New York ferry companies have not adopted some form of electric windlass for pulling heavy loads off ferry boats and up the steep inclines of the ferry slips, so frequently caused by low tides. To say nothing of the saving of horse and man-flesh and of the time of the trucks, there is the saving of time of the ferry boat and the assistance which speedy loading and unloading would give in maintaining an exact schedule.

American Institute of Electrical Engineers

Lightning Arrester Papers Read at Last Month's Meeting

Some Experiences with Lightning Protective Apparatus

By Julian C. Smith, Superintendent of the Shawinigan Water & Power Company, Montreal.

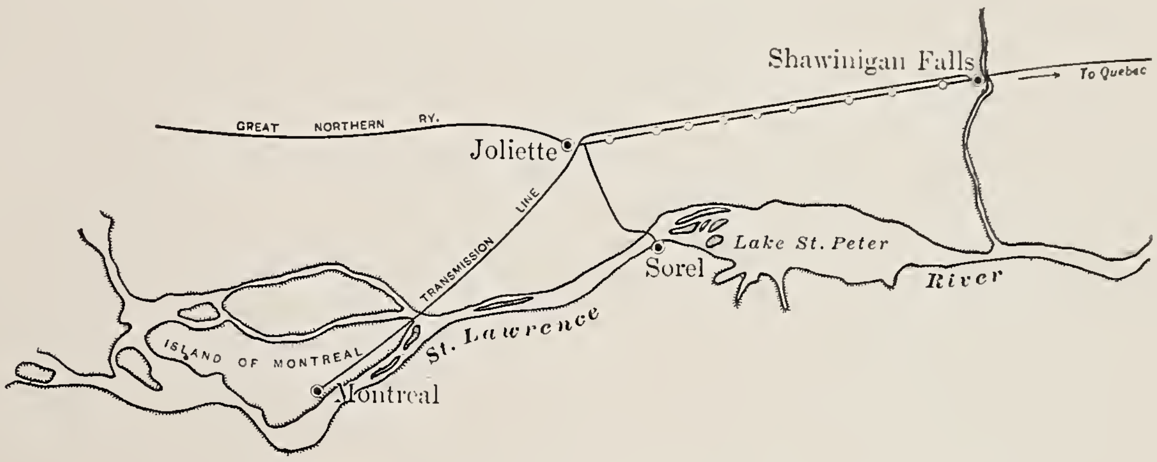
THIS paper will deal with some experiences with lightning protective apparatus which the operating department of the Shawinigan Water & Power Company has had during the years 1903, 1904, and 1905.

The generating station at Shawinigan Falls has three generators, each of 3750-KW. capacity, 2200-volt, 30-cycle, two-phase, and one generator of 6600-KW. capacity, 2200-volt, 30-cycle, two-phase. Each of these generators is direct connected to a water-wheel operating under a head of 130 feet.

Referring now only to the long-distance lines, it is sufficient to note that the energy is delivered through a double set of bus-bars to the low-tension side of the step-up transformers. These transformers are T-connected for transforming from two-phase to three-phase. The ratio of voltage transformation is 2200: 50,000. The neutral points of these transformer banks is grounded, giving about 29,000 volts between each wire and earth.

In 1903, only the No. 1 Montreal line was operating. This line connected the generating station at Shawinigan Falls, P. Q., with the Montreal terminal station, situated just outside the city of Montreal. The distance from the generating station to the terminal station is 85 miles. The transmission line consists of three 7-strand aluminium cables, each of 185,000 cir. mils cross-sectional area, spaced 60 inches apart and arranged in the form of an equilateral triangle with the apex upward. These cables are supported on 35-foot poles, with cross-arms 6 feet long fastened with through bolts. The top of every pole is bored to receive a pin. All pins are 18 inches long, and were boiled in stearine. The voltage at Shawinigan is normally about 50,000; at the Montreal terminal station it is 44,000.

In the spring of 1904, a sub-station was built in Joliette, distant about 45 miles from the generating station, and from this sub-station a branch line was built to the city of Sorel. This line is about 20 miles long and is operated at 12,500 volts. The only special point of interest is a submarine cable about 5000 feet long by means of which the line crosses the St. Lawrence River.



A MAP OF THE SHAWINIGAN FALLS-MONTREAL TRANSMISSION LINE

In the Montreal terminal station, the voltage is reduced to 2400 and supplied to a set of 30-cycle bus-bars. From these bus-bars the frequency changers are operated. Each frequency changer consists of a 30-cycle synchronous motor connected to a 60-cycle generator. There are at present installed in this station five of these motor generators each of 1000-KW. capacity and one of 5000-KW. capacity. In addition to these machines there are two synchronous converters, each of 1000-KW. capacity, operating street railway circuits. It is interesting to note that the whole load of the long-distance line consists of synchronous apparatus, and that by properly regulating the fields of this apparatus the power factor can be kept at unity.

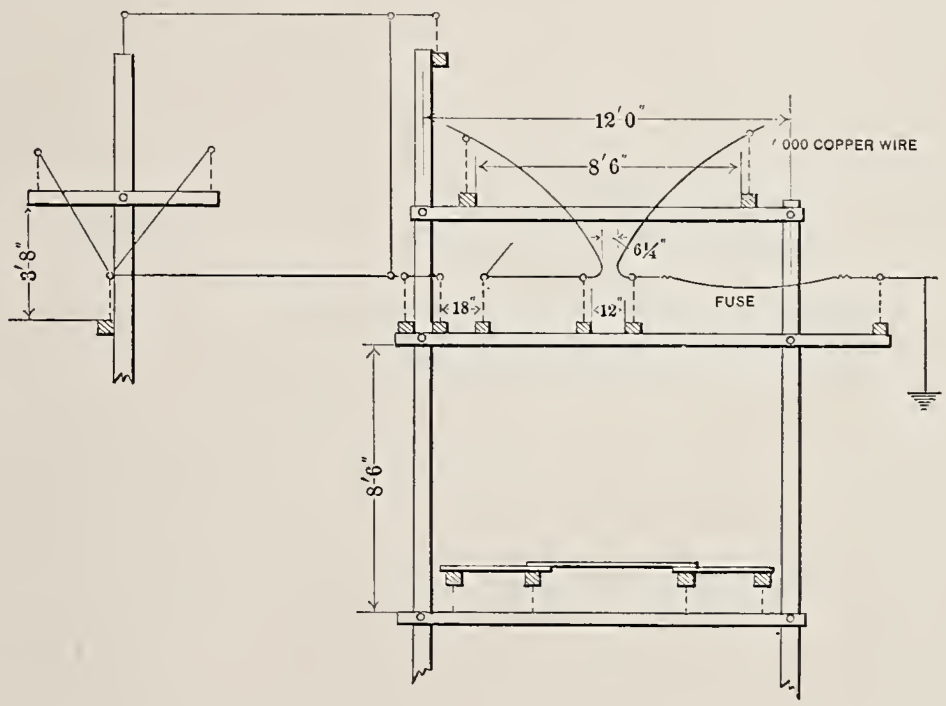


FIG. 1.—HORN LIGHTNING ARRESTER, JOLIETTE

In the fall of 1904 the No. 2 Montreal line was completed. The No. 2 line is parallel to the No. 1 line for nearly the entire distance, and in

most places is not more than 100 feet distant. The second line is similar to the first except for the size of the conductor and for the fact that house lightning arresters of the low-equivalent type and a bank of static interrupters. The number of gaps in these arresters was decided upon only transmission lines, the Laurentian Mountains bound the north side of the St. Lawrence Valley. In general, the country over which the

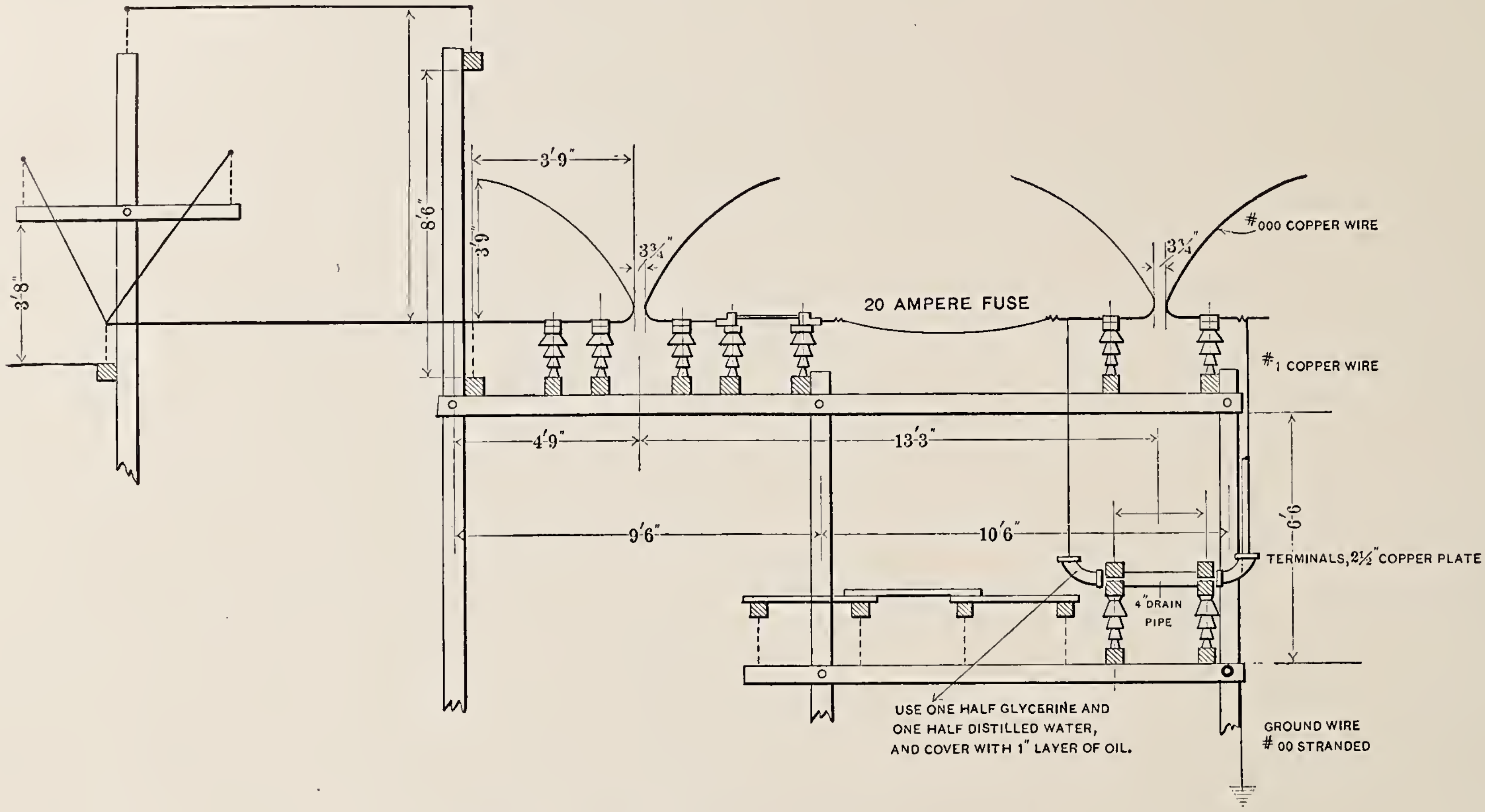


FIG. 2.—HORN LIGHTNING ARRESTER AND RESISTANCE, TYPE 1905

a ground-wire is strung along the line at the neutral point of the triangle.

This ground-wire is connected to the earth at each pole by a wire running down the pole.

When the No. 1 line was put into service the lightning apparatus installed was as follows:—At each end of the line was a bank of Westing-

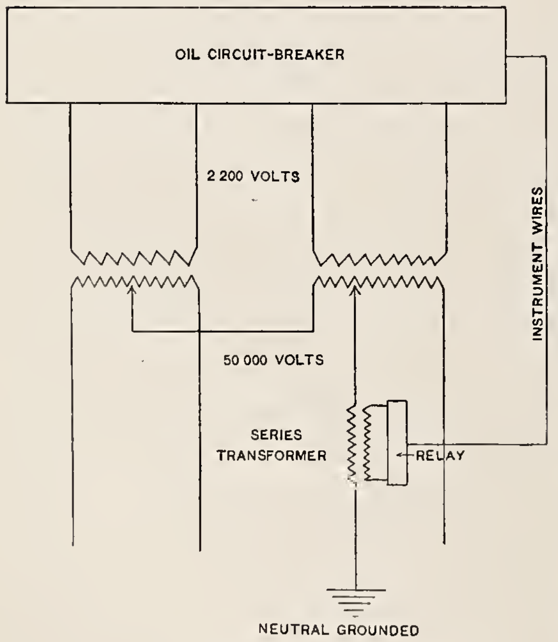


FIG. 3.—TRANSFORMER CONNECTIONS

Note.—Neutral point grounded through a series transformer and relay. Current in groundwire trips oil circuit-breakers.

after a series of tests had been made to determine the lowest practicable break-down voltage. These arresters were set to discharge at about 65,000 volts.

In 1904, a bank of General Electric arresters was placed on the 50,000-volt line in the Joliette sub-station. This bank was also adjusted to discharge at about 65,000 volts. In 1904 three banks of horn arresters were put on the No. 1 Montreal line. These arresters consist of bent copper rods. The horns were spaced 6.25 inches apart at the gap, this distance corresponding to a break-down voltage of 90,000. See Fig. 1. In 1905, when the No. 2 line was equipped with lightning arresters, three banks of low-equivalent arresters were put in, one at each end and one at Joliette. In addition to these arresters, three banks of the 1905 type of horn arresters were put in. Some changes were made in the setting of these arresters as will be noted farther on.

The Montreal lines run in a general northeasterly southwesterly direction, parallel to the St. Lawrence River and about 20 miles distant from it. The elevation of the power house is about 200 feet above sea-level, that of the sub-station being nearly the same. Some 10 miles farther north and parallel to the lines pass is a flat farmland, but near the power station the country is very rough.

The prevailing winds are westerly, and the general course of the electrical storms is parallel to the lines. The storm period extends from March to October. Nearly all the storms occur during the latter part of June, and in July, August, and early in September. The storms are most severe during July and August. In the territory covered by the lines of the Shawinigan company there occur during each year about fifteen thunderstorms. As these storms move along in an easterly direction and sometimes take days to cover the 100 miles, we have found that from June 25 to September 10, a storm is reported nearly every day from some part of the line. In general, however, there are not more than four or five severe storms during each year, and these storms are most severe in well defined localities.

The discussion of our experiences with lightning will be simplified if these experiences during 1903, 1904, and 1905 are considered separately, year by year.

As stated above, the only line in operation in 1903 was the No. 1 Montreal line. That line was protected by low-equivalent arresters at

each end. During the summer of 1903, several disturbances occurred, which may be summarized as follows:—

1. Poles splintered by heavy discharges.

2. In a few instances, insulators broken.

3. Flashes across the static-interrupted terminals.

4. Arcs on the transformer terminals.

5. Arcs inside the transformer cases at the top between adjacent leads.

6. Damage to apparatus caused by 3, 4, and 5.

7. Interruption to service, due usually to excessive voltage-drop, causing synchronous apparatus to fall out of step.

1. On several occasions poles were splintered. In most cases two or three poles were torn to pieces; the adjacent poles on both sides were less damaged, the damage decreasing as the distance increased from the point of disturbance. One of the worst cases recorded by us shows that 5 poles were torn to pieces while 10 poles on each side were somewhat splintered. This disturbance extended over a distance represented by 25 poles, or about 2500 feet. This case, however, is exceptional; usually not more than one pole is badly damaged, and a few of the nearby poles slightly splintered.

2. In only one or two instances were insulators broken; in each instance it was the top insulator. In these cases, the breakage seemed due to the flashing over and consequent heating, as the insulator was not in any case punctured. In no case was an insulator so badly damaged as to need immediate replacing.

3. At the same time that the poles were splintered on the line, there would be evidences of excessive potential in the stations. The most frequent occurrence was an arcing over on the terminals of the static interrupters. In some cases this flash would reach across to an adjacent static interrupter and establish a short circuit between the lines. In most cases, however, it was simply a flashing from the ends of the terminal to the case, or between the incoming and outgoing wires of a single static interrupter, thereby short circuiting the reactance coil.

4. The arcs on the transformer terminals were more rare, only occurring when the static interrupters were put out of service by the flashing over mentioned above.

In view of the above disturbances and damage, it was decided to put in a type of horn lightning arrester affording a low resistance path to ground, to depend on a fuse for the interruption of the short circuit which would occur if the horns did not break the arc, and to set these horns so that only the heavier discharges would break them down. The horns were consequently adjusted to discharge at about 90,000 volts.

At the end of 1903, it was determined that the arresters installed were sufficient to meet the conditions caused by ordinary storms. They protected the line from abnormal rises of potential due to switching or short circuits; but in those cases when the lightning-stroke damaged poles on the line the rise of potential was so high and took place so rapidly that the arresters could not carry enough current to keep the potential of the line within safe limits. The horns installed were especially designed to meet only the conditions which were not met by the standard arresters.

In 1904 there were more than the usual number of storms. On the following dates the horns discharged:—

Date	Shawinigan	Joliette	Montreal
July 11	3 horns	1 horn	None
Aug. 5	2 "	3 horns	"
Sept. 20	2 "	2 "	"

One or two storms did not cause any disturbance.

The storm of July 11 was central near the power station, and one pole about 5 miles distant was splintered. The Joliette horns discharged about an hour before the discharges took place at Shawinigan.

On August 5, the storm was central at Joliette. Both the horn arresters and the standard arresters discharged violently, the horns at Shawinigan discharging at the same time. There was evidently a rise of potential in the Joliette station, as one of the glass windows through which the wire enters the building was cracked, due to the flashing over which must have occurred. At the same time that this disturbance occurred in the station, some 25 poles about 5 miles away were splintered, a few of them very badly. No disturbance other than the discharge of the arresters occurred in the other stations. The service was not interrupted, a rather severe blow being felt, lasing only about a second.

On September 20, the storm was central about midway between Shawinigan and Joliette. Fifteen poles were struck. No excessive potentials were noticed in the stations, nor was the service interrupted.

During 1905, the number of storms was less than usual, but there were two very violent storms, both near Shawinigan. Poles on the No. 1 line were damaged. At various times during the summer the horns of both lines discharged, but it is noteworthy that the horns of the two lines did not discharge at the same time; that is, the two lines only about 100 feet apart would not be equally affected by lightning discharges.

The horn arresters on the No. 2 line were designed to take less current than those on the No. 1, as a resistance consisting of a mixture of glycerine and water was put in the ground connection; in parallel with this resistance was a horn-gap. During the first storms it was noticed that the resistance had "an equivalent spark-gap" greater than the horn, although the resistance was about 10,000 ohms and the gap about 3 inches. The resistance was greatly decreased early in the summer by pushing the terminals closer together and the gap was slightly increased. After this was done the lightning discharge went through the resistance.

Another factor came into play in 1905. The two long-distance lines are operated in parallel on the low-tension sides at both ends. As stated previously, the neutral point of the transformer banks is grounded at Shawinigan. A series transformer was placed in the ground-wire leading from each bank of transformers, and an overload relay connected to this series transformer, so that if any considerable amount of current flowed into the neutral the relay would open the low-tension side of all of the transformers connected to that line. The operators in the Montreal terminal station were depended upon to separate the two lines in cases of trouble. By this means, a ground or heavy disturbance on one line would cut that line out of service. Our experience during the past year shows that this scheme works satisfactorily. To some extent, however, it masks the action of the lightning arresters, as in case of heavy discharges over the horns the relay would cut off the line.

Summing up our experience with reference to the horns, I would say that we consider them a valuable addition to the standard equipment. Since the installation of the horn arresters, we have had no arcs in our station. No damage has been caused to our apparatus. No interruptions to our service have been caused directly by lightning. On the other hand, each time the horns discharged a more or less severe short circuit occurred, in no case, however, being severe enough to cause trouble or to cause our synchronous apparatus to fall out of step.

Lightning Arresters on Italian High-Tension Transmission Lines

By Philip Torchio, Engineer of Distribution of the New York Edison Co.

DURING a recent trip abroad the writer inspected several high-tension transmission lines in Italy, and found that American lightning arresters with choke coils are quite generally used at the ends of the lines. In addition, Siemens horn arresters are sometimes installed at the ends of the line and at intervals on poles along the line.

The protection furnished by these devices, however, is not considered sufficient, on account of their inability to protect the line and the machines under all conditions of lightning discharges and surges, or even static disturbances caused by load fluctuations in the ordinary operation of the system. Transmission engineers have found it necessary to supplement the ordinary lightning arresters with some other protection, and to that end a variety of devices has been developed on different installations. Among these the so-called "Series Lightning Arrester" of Gola, and the "Water-Resistance Static-Discharger" call for special attention. The series lightning arrester has been described in the technical papers (see Transactions of the Associazione Elettrotecnica Italiana, January and February, 1905, in which are also cited earlier publications relating to this form of arrester).

It is claimed by Gola that the shortcomings of the ordinary commercial lightning arresters are due to some deficiency in the choke coils employed and not to any deficiency in the lightning arresters themselves, their function being only to discharge the line. To overcome the shortcomings of such choke coils, Gola devised an apparatus in the shape of a large shell, consisting of a choke coil and a number of large cast-iron diaphragms and shells connected in series by means of small copper conductors, the whole being placed in series on the line to perform the functions of a choke coil, and also to introduce an abrupt and great change in the section, material, and shape of the line conductors leading to the station apparatus. The device is illustrated in Fig. 1. In proximity to the sharp-edged ends of the shell are located corresponding air-gap, horn-shaped lightning-dischargers which are connected, through a resistance to ground, either directly here, or in series with ordinary lightning arresters, according to the requirements demanded by the line voltage. The function of the supplementary lightning arresters is to assist the main air-gap in rupturing the arc after the lightning discharge has taken place. It is claimed that while this device will allow the main line current to pass undisturbed, it will so obstruct the passage of lightning or static-discharge currents as to cause them to be reflected at this point and pass to ground via the dischargers above mentioned. This obstruction is claimed to be due to several effects of discontinuity of the circuit, in so far as the "homogeneous circuit of the line conductors of approximately constant section and of the same material (generally copper), always in a diamag-

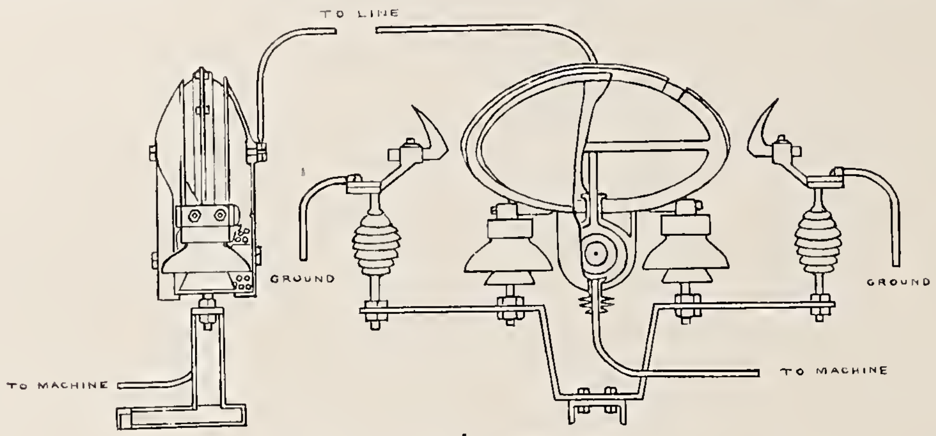


FIG. 1.—GOLA'S APPARATUS

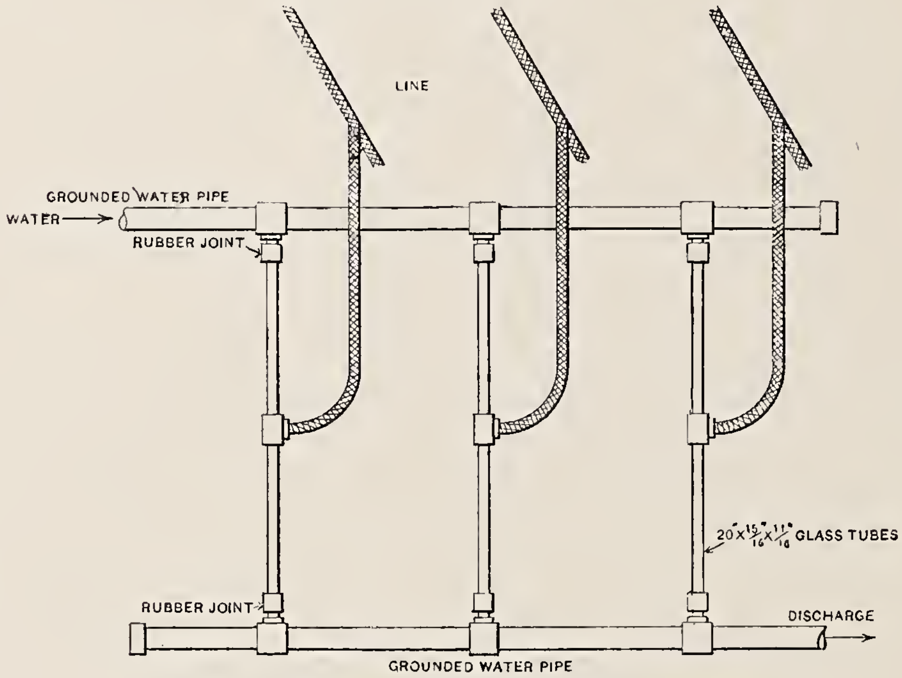


FIG. 2.—WATER RESISTANCE STATIC DISCHARGER

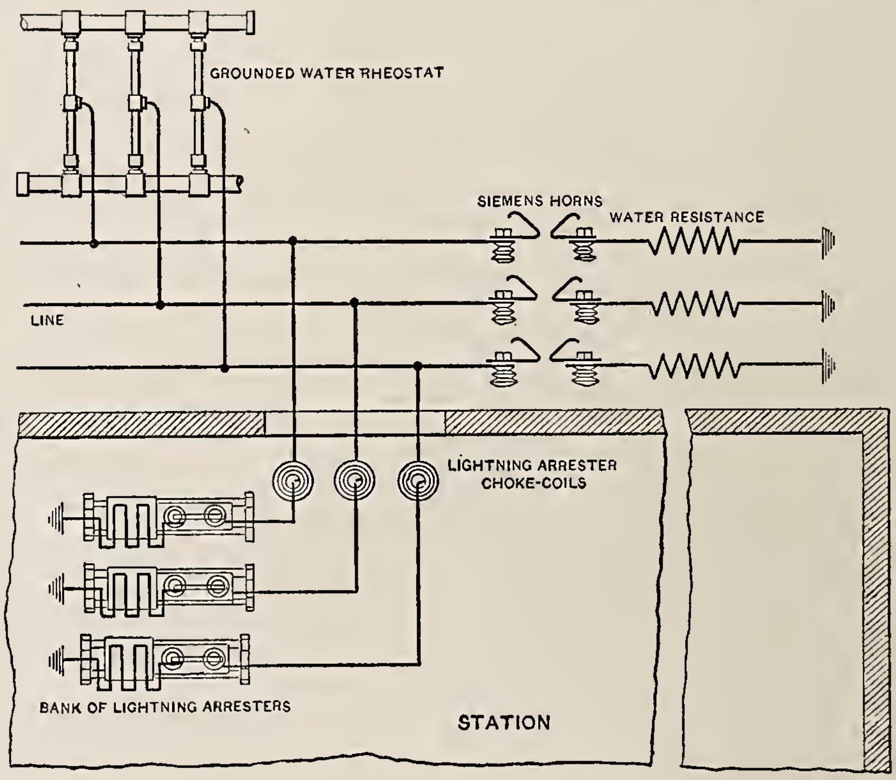


FIG. 3.—SCHEME OF STATION PROTECTION

netic medium (air or insulating material), is suddenly interrupted by the introduction of several lengths of conductors of magnetic material of section and surface enormously greater, joined one to another by lengths of copper conductors again of small section, but placed in a magnetic medium, the whole with sudden changes of direction and section."

Gola, in the publication above referred to, makes several interesting comparisons between hydraulic and electrical laws, and by analogy attempts to explain the operation of the series arrester. The device has been used in many places in Italy for the last two or three years. In many cases it has proved to be most effective, while in other cases the results have been indifferent.

The "Water-Resistance Static-Discharger" of Friese and others is connected at each end of the line, one discharger between each conductor and ground, thereby forming a permanent continuous path to ground for a small fraction of the main-line current. A general feeling prevails that this grounding will eliminate a great many troubles from lightning and surges on the line. Several ways of grounding the line are in use in Italy, but the one at the Morbegno station of the Valtellina three-phase railway may be considered as representative of the water-resistance type of grounding device. The device, which is shown in Fig. 2, is mounted on an iron frame outside the station. It consists of grounded feed and discharge water pipes supplying the necessary water to three pairs of glass tubes, each pair being joined at the middle by a metallic union to which are brought the grounding connections from the line conductor; the grounding is made through the two water tubes in parallel. The current to ground in this system, operating at 20,000 volts (11,000 volts to ground) is 0.2 ampere from each line wire to ground. The superintendent of the station was hopeful of the success of the device.

At the Paderno station of the Milan Edison Company a different arrangement of water-resistance static-discharger was being installed at the time of the writer's visit. It consisted of only three large glass water-tubes, but of greater diameter and length than those used in the Morbegno station. In this case it was also expected that the device would give satisfactory results.

Summarizing the observations made by the writer, the best practice of to-day for the protection of Italian transmission lines indicates that the plan illustrated in Fig 3 should be adopted. The plan shows that:—

1. The terminals of the transmission lines should be extended in a direct line some distance away from their entrance into the station, and the ends should be equipped with Siemens horn arresters grounded through water resistances.

2. On the line side of the branch entering the station a water-resistance static-discharger should be installed.

3. Choke coils and ordinary lightning arresters should be installed inside the station. Possibly, choke coils of the series lightning-arrester type should also be added.

4. Siemens horn arresters should be used on the poles along the line only after careful study of the installation. Series lightning arresters, with Siemens horn arresters, or ordinary lightning arresters may, however, be installed at particular points; as, for instance, where a line divides into branches, or at special points of a line installed in a mountainous country.

Lightning Arrester Records

By A. J. Neall, of the Westinghouse Co.

A paper was read also by A. J. Neall, of the Westinghouse Electric & Manufacturing Company, entitled "Performance of Lightning Arresters on Transmission Lines."

The paper described a method of obtaining, by means of test papers, records of the operation of lightning arresters in service, and gave some results obtained by the use of this method on several transmission lines.

A method for registering lightning-arrester operation, Mr. Neall said, should have the following characteristics:—(1) It should be applicable to all types of arresters; (2) simple to install; (3) not interfere with the operation of the arresters; and (4) it should be positive in its information.

These requirements were met in the test papers furnished by the Westinghouse Electric & Manufacturing Company to a number of operating companies about one and one-half years ago, who agreed to investigate this matter under its auspices.

The general idea in the distribution of test papers was so to cover the country that the same apparatus at different localities would come under comparison. There was no endeavour to make a thorough comparison of all types of arresters used, chiefly because the selection rested with plants in operation, and the main investigation was to be of the effectiveness of the arrangement of gaps and resistances in the low-equivalent lightning arrester. Incidentally, however, some interesting results were obtained on other types at what happened to be comparable voltages of transmission. Incomplete reports were obtained from other plants, with occasional records of special interest.

The range in voltage of the high-tension plants under observation extended from 6600 to 55,000, particular interest attaching to returns at 25,000 and 30,000 volts. The tests covered territory extending from Maine to California.

DISCUSSION

After the reading of the papers President Wheeler said he thought it was fortunate that the matter of lightning protection had been brought up at this time. He regretted, however, that the general subject of damage by lightning had not received attention, as this is a matter in which the public is now very much interested. He then called on Mr. Thomas to open the discussion.

P. H. Thomas said, in part, that in considering the great variety of forms of arresters, it is well to remember that there are only one or two really fundamental points about an arrester, namely, the air gap and the chances for the static charge to dissipate itself, also means for interrupting the arc. However ingenious the form of the gap, these facts cannot be evaded.

Another type of arrester is that in which a high resistance is interposed between the line and ground, which will undoubtedly carry off slow accumulations of electricity. The questions that arise are:—

Are present resistances too great for free discharge?

Is it possible to use less resistance than is now employed and still keep the arresters non-arcing?

Is it possible to use a less resistance in the horn type of arresters than in the multiple-gap type?

Can any system be arranged by which it is feasible to protect lines by the use of fuses to interrupt the discharge?

The difficulty here is to protect the line after one discharge has occurred, and to insert another fuse without disturbing the operation of the synchronous apparatus.

A little experiment will frequently determine the arrangement that will protect the whole line. There may be many plants in which the horn arrester, without series resistance and without fuses, may operate for throwing out synchronous apparatus or circuit breakers, but usually it will

be necessary to have series resistance also, in which event one may as well rely altogether upon the multiple-gap arrester or fuses.

C. F. Scott commented on the fact that many of the papers on this subject treat lightning as if it were a definite thing, whereas the phenomena of lightning and the character of the lightning discharges are many and varied. One of the valuable features of Mr. Neall's paper was that his method of treating the subject tended to bring together what would otherwise be a great collection of isolated examples, thereby affording opportunity for generalization, bringing, as it does, to the attention of the man who is operating the station a means of studying the conditions at different points on his line and the different kinds of discharge.

The protection of the poles on transmission lines against damage by lightning discharges was, Mr. Scott thought, one of the most important questions to be considered in connection with the whole subject. In Mr. Smith's paper numerous instances of splintered poles were noted, whereas there was apparently no injury to the station apparatus, within his experience.

W. S. Franklin did not see what possible value could be derived from knowing that a lightning arrester operates successfully a great many times in the year with small discharges. What is important to know is the number of failures of the lightning arresters that result in damage to the apparatus or to the pole line. With regard to the use of water resistances in the case of line discharges, he desired to call the attention of the Institute to what seems an obvious fact, namely, that the kind of resistance that is needed is one which offers a comparatively low resistance for quick discharges, and a comparatively high resistance for a slow flow of current,—that is to say, a skin resistance. The use of resistances in series with spark gaps has not been pushed to the extent that it should be in the development of lightning arresters. The idea of the speaker would be to use a series of 3-foot pipes of terra-cotta, painted with platinum chloride, spread out on a surface about 6 feet broad. This arrangement would present an enormously high resistance to a slow pulse of current corresponding to the frequencies of the generators, and at the same time it would present a comparatively low resistance to the excessively quick rushes of current which constitute lightning discharges. In the same way, when a pole acts as a lightning conductor, something should be done to prevent the current from flowing through the fairly high resistance of the wood, inasmuch as a high resistance substance does not conduct on the skin only, but through the material. If the pole were made of copper, it would conduct the high frequencies of the lightning discharges only on the surface, but being of wood, even these extremely quick pulses of current are able to penetrate into the very heart of the pole.

H. C. Worth expressed the opinion that all types of lightning arresters gave more or less trouble. He has found that it is not safe to draw any conclusions from investigations extending over a short period; also, that the puncturing of paper may occur very frequently, but that may not be a correct representation of the operation of the arrester. These punctures must be very carefully examined by an expert before any satisfactory conclusion can be drawn from them.

H. G. Stott thought that lightning divided itself into two classes,—one which corresponds somewhat to the surging mentioned in the papers, which no doubt can be taken care of, while the other class corresponds somewhat to the explosion of a ton of dynamite and cannot well be taken care of. The first class of discharge can be taken care of in a simple manner, rather expensive in the first place, but not in the last. With regard to the second class, the shocks of static discharges, the insulation of the line and apparatus must be improved so that it will be able to withstand the shocks.

With regard to underground lines, experience has shown that all ordinary discharges can be taken care of simply by improving the class of insulation of the condensers, cables, etc. In the case of the second class of discharge there are two contradictory requirements. One is to provide the best possible path to earth for the lightning discharge; the other is to provide the worst possible path to earth to prevent the line current following that path. It is not possible to harmonize the two requirements. A plan that might be worth trying would be to put in a single gap, with no resistance whatsoever in series with it, but with the current transformer provided with an oil switch in the earth connection. The relay operated by the current transformer would, in case of a severe discharge to ground, drop out the oil switch, but would protect the arc for a predetermined time. The generator relay, being set for a higher time, would not act.

C. P. Steinmetz discussed the papers at much length. In part, he said that there is not the same absolute confidence in the performance of the lightning protective apparatus in an electrical power circuit that there is in the remaining apparatus of the system—notwithstanding what overconfident engineers and designers of lightning arresters may state. The reason is obvious. Lightning comprises a complex phenomenon, concerning which our knowledge is not as extensive as could be desired.

If lightning were always a very high-frequency oscillation, like the discharge of a Leyden jar, it could be guarded against by interposing reactive coils between the station and line, and shunting the discharge by multiple spark gaps to ground. If it were always a steady, gradual charge and discharge of the line, the line could be discharged by a high resistance shunt toward ground, with or without a spark gap. If it were always a low-frequency high-power surging, the attempt could be made to take care of it. But lightning is neither the one nor the other, constantly, nor the surging, but may include all three phenomena or any two of them at the same time. Only by combining the most valuable features of the various lightning arresters can we expect to obtain a lightning arrester that will protect the system, at least in most cases, against all discharges of reasonably limited magnitude. For unusual discharges, like the explosion of a ton of dynamite, such an arrangement would not suffice.

The important features of these high-power discharges is their extreme suddenness, which causes damage at the point of entrance, usually in the middle of the transmission line, without transmitting sufficient energy to the terminal station to be very serious at that station. In other words, such very high-power discharges shatter and destroy transmission line poles, but are rarely so much to be feared at the station, except when the discharge occurs very close to the station.

Messrs. J. H. Hallberg, H. C. Worth, W. H. Patchell, and E. W. Stevenson also participated in the discussion, which was closed by Messrs. Torchio and Neall, after which the meeting adjourned.

One of the several advantages of electric motor driving is the adaptability of the system to changes and extension. New motors may always be added without affecting any already in operation.

Developing a Water Power

Elements of Financial and Commercial Success

By THORBURN REID

SEVERAL years ago the writer was retained by a small municipality to investigate the feasibility of transmitting electrically the energy of a small water-power a distance of 16 miles for the purpose of lighting the town and furnishing power during the day for factories. It was reported that 400 H. P. were available, that much work had already been done towards developing the power, including the building of a canal 10 feet deep, 30 feet wide, and about 3000 feet long, and that all this property could be bought at a figure lower than the cost of the work already done.

Careful investigation showed that scarcely a single factor of commercial success was present. The power had been enormously overrated, and was very variable; the cost of development was very high; and there was practically no market for the power in the immediate vicinity.

On one side of the canal spread a low plateau, about a mile square, with perhaps half a dozen small houses scattered about. Faintly outlined by pine stakes, could be seen the lines of streets and avenues covering the whole plateau, and on one of these avenues, almost hidden by the thick grass, appeared the rotting ties and rusty rails of what had evidently once been a street railway. The canal had been well made, and was probably of sufficient capacity to supply from six to eight hundred horse-power. About midway of its length were the remains of a timber bulkhead and overflow gate. At its lower end the forebay bulkhead and gate with the timber foundations for the turbines were still in good condition, and the solid stone walls of the power house foundation were a foot or so above the grass and blackberry bushes clinging to their sides.

In a barn near by, were unearthed, from under the hay in the loft, the turbine shafts, steel casings, bearings and gear wheels. The water-power property, including the canal, the timber work, power house and machinery and several acres of land between the canal and the river, were offered for sale at a price that must have been considerably less than the cost of labour and material. The whole was a melancholy example of misdirected energy and useless expenditure, and was typical of many similar cases that come to light from time to time.

The power had been originally estimated at 800 H. P., but when first brought to the writer's attention the estimate had been reduced to 400 H. P. After a careful study of the situation and investigation of all the records available, the writer reported that by means of the slight additional head and the storage of water afforded by the construction of a low dam across the river at the head of the canal, 175 H. P. could be counted on for the few hours each day when the load would be heaviest, that being the limit of the power to be expected during low stages of the river. Here, then, was a clear example of overestimation of power available, excessive cost of development and operation, and an almost complete lack of market for the power when developed.

In its final analysis the object sought in the development and utilization of any water-power is a reasonable profit on the investment required. Simple and obvious as this proposition may appear, it is, nevertheless, very often lost sight of or obscured by the multitude of details that must be considered in the preliminary investigations, and the engineer generally finds it just as necessary to direct his client's attention to this fundamental requirement as to insist on the inclusion in the investigation of every factor that may affect the object sought.

For convenience, these factors may be classed in three divisions: first, investment required; second, operating expenses; third, income.

INVESTMENT REQUIRED

The sources of expense properly chargeable to the investment account are:

1. Preliminary investigations.
2. Promoting and organizing.
3. The necessary real estate and water rights.
4. Franchise and rights of way for pole lines, etc.
5. Hydraulic work, such as the dam, canal, etc., the power plant, transmission line, sub-stations and distributing system. Under this head should be included the engineer's fee for designing and supervising the plant, and the salaries of any officers who may be receiving pay during the constructional stage.
6. Interest on all money expended during the preliminary and constructional stage, or until the plant has been completed and is delivering power to customers.

During the subsequent history of the plant questions often arise as to whether certain disbursements for additions or improvements should properly be charged to investment or to operating expense. So varied are the considerations affecting such disbursements that no general rule can be formulated that will automatically relegate each to its proper account; but the general principle may be laid down that no expenditure is properly chargeable to investment account that does not increase proportionally the net profit derived from the plant either by increasing the income or decreasing the operating cost.

Indeed, unless this condition is satisfied, such expenditure should not be incurred unless some unforseen contingency makes it necessary in order to prevent a reduction in the net profit. In such cases entirely extraneous considerations, such as the form of the company's securities or the effect on the market of these securities, may decide to which account the expenditures should be charged. That is, charging to capital account may mean a permanent reduction in the dividend rate, while charging to operating cost might mean a temporary reduction, with a subsequent return to the full dividend rate.

A well-managed company, however, should accumulate a surplus which would be applicable to such unforseen expenditures, thus preventing a disturbance of the dividend rate. Such surplus should be charged to operating expenses, and will be

considered more in detail under that head.

It is not possible in this article to go into the details of the items constituting investment expenditure, but a few general rules may be stated.

First. It is scarcely possible in the preliminary report to work out the cost in too great detail. The engineer is often tempted to guess at the smaller items of cost or to cover his laxity by large allowance for "contingencies," alleging the changing prices of material and labour as an excuse for inaccuracy. The item of "contingencies" is expected to cover some unforseen rise in the price of material or labour, the failure of a contractor, or the necessity for some extra expenditure due to unusual conditions developed only after the work was started, but not to cover any expenditure that could have been foreseen and allowed for by the engineer before the work was commenced. Even with the most painstaking and detailed estimate the actual cost shows a strong tendency to exceed it, so much so that most engineers with experience in such enterprises make a liberal allowance over and above their first estimate.

Second. Cheap material and labour are fatal to success. They are the prolific source of stoppages and breakdowns, and the consequent expenditure for repairs and the loss of income will often use up in one year the whole saving in the cost of cheap material over that of the very best which the market may have afforded.

Third. Aside from the engineer's allowance for unforeseen contingencies during construction, ample allowance should be made for carrying the enterprise along until income from the sale of light and power shall equal or exceed the operating expenses. Even though the demand in the territory to be supplied may far exceed the capacity of the plant, it takes time, nevertheless, to educate customers, and time for them to obtain necessary apparatus and make the changes required before they can be connected in, and during this building-up period operating expenses will be nearly, if not quite, as high as when the plant is running at its full capacity.

Fourth. The warning against overrating the amount of power available cannot be repeated too often or emphasized too much. Such power overrating is an almost universal error, and even the most conservative of engineers is liable to make it at times. A single measurement of the stream flow, or a number of isolated measurements are valueless, no matter how positive the natives may be that the stream at the time is as low as it ever becomes. Their untrained observation has time and time again proved to be worthless, and nothing less than a series of gauge measurements extending over a series of years and supplemented by accurate flow measurements at low stages of the stream ought to be trusted, if anything like accuracy be required.

Calculations based on the drainage area alone are nearly always unreliable. The minimum power to be obtained from a stream is not based on the average amount of water it discharges, as is evidenced by the fact that some streams with considerable drainage area run entirely dry at times. Of course, where sufficient reservoir capacity can be obtained to store up the water and discharge it at somewhere near the average flow of the stream the year round, calculation of the drainage area and run-off becomes of value, but such cases are rare. Many engineers still continue, apparently from force of habit or with a blind following of precedent, to incorporate in their reports elaborate investigations of drainage area, precipitation, and run-off, when, in fact, the power available at the lowest stage of the stream is the important point to be decided. Such investigations are rarely worth the time required to make the calculations involved.

Unless, then, the stream under consideration has been systematically measured and gauged for a long period, its minimum power can only be guessed. The conservative engineer will divide the lowest by two, and, if he has had much experience, will feel a little doubtful even then.

Fifth. Floods will often reduce the output of the plant far below its normal capacity, and may cause it even to be shut down entirely. Such stoppages are nearly always disastrous to the profitable operation of the plant, and unless some means can be provided to conserve the effective head on the water-wheels at such times, some auxiliary source of power, such as steam or gas engines, must be kept in reserve. To most people it seems a great waste of money to tie it up in machinery that will be productive for, perhaps, not more than two or three weeks a year; but where uncontrollable floods are inevitable and a shutdown of the plant is not feasible, such expenditure must be made, and should be considered as proper part of the cost of development. The first cost of this auxiliary plant may be much reduced by disregarding high fuel economy. This is warranted by its short term of operation, since the saving in interest on first cost and other fixed charges will usually far overbalance the cost of the excess fuel consumed during its restricted period of operation.

OPERATING EXPENSES

The operating expenses of a water-power plant are very nearly constant, no matter what may be the ratio of output to capacity. Certain expenses, such as interest, insurance, taxes and depreciation, are constant in any kind of power plant. The other items of expense,—repairs, labour and supplies,—vary somewhat with changes in the output; but the variation in these items is much greater in a steam plant than in a water-power plant. In addition to this, in a steam plant, or any plant obtaining its power from the consumption of fuel, the fuel cost, which amounts, roughly, to one-third the total operating cost, will vary nearly in proportion to the output. The operating cost of a water-power plant per horse-power will, therefore, vary very nearly inversely with the output, while in a steam plant it decreases much more slowly than the output increases. The importance of a market for the full capacity of the water-power plant is thus made apparent.

The operating cost of a steam-power plant includes all the items required by a water-power plant and adds to these the cost of fuel. In a water-power plant the item corresponding to cost of fuel could be called "cost of water," a practically constant quantity, being interest, insurance, taxes, depreciation, repairs and supplies for that part of the plant which serves to bring the water under pressure to the water-wheels and to carry it away from them after it has done its work. The so-called fixed charges,—interest, insurance, depreciation and taxes,—are practically dependent on the first cost of the plant. The other charges are labour, repairs, supplies and administration expenses.

As to labour, the most important requisite is to pay sufficiently high wages and salaries to secure first-class men in positions of responsibility. A competent chief engineer will usually save each year many times the difference between his pay and that of an inferior man. Each breakdown due to carelessness, ignorance or incompetence means, besides the cost of repairs and the loss of income, an impairment of public confidence, which will do more to imperil the financial success of the plant than almost anything else that can happen to it. In small plants of a few hundred horse-power capacity the question of how much the company can afford to pay for a chief engineer

is a difficult one to decide, but in general it is better economy in the end to pay more rather than less than at first may seem advisable. In large plants, running up into thousands of horse-power, the main difficulty is usually to find a man good enough for the place at any price.

After the heads of departments have been secured, the responsibility of hiring their subordinates and of operating the plant should be laid firmly upon their shoulders, and they should then be judged entirely by results. Interference by the management between the heads of departments and their subordinates is fatal to discipline and to effective effort, and, in addition, the department head has for excuse, if things go wrong, that orders were given by others than himself. Excuses from a department head should not be entertained. Give him what he asks for, if it be reasonable, and then require results. If he cannot get results, discharge him and get a better man who can.

The main requisite in regard to repairs is that they shall be made promptly and thoroughly. Nowhere is the old adage, "a stitch in time saves nine," more true than in the running of a power plant. At the slightest indication of something wrong in any part of the machinery, the defect should be immediately ferreted out and remedied.

Experience has shown that certain parts of the machinery are peculiarly liable to failure at short notice or without warning. In order to avoid costly stoppages it is imperative that such parts be kept in stock, ready to immediately replace the damaged ones. In fact, so great is the loss from stoppages that in most plants an extra power unit is warranted, to take the place, at a moment's notice, of one that is injured. When the plant runs fully loaded for only a few hours out of the twenty-four and one or more units are idle for a large part of the time, duplicates of those parts which are most liable to breakdown will usually be sufficient.

As to supplies, their cost is but a small part of the total operating expense, and the only requisite is that they shall be the best of their kind for the purpose.

One of the most important divisions of operating expenses and one which is most frequently slighted, or even altogether overlooked, is depreciation. The depreciation charge has been a source of much controversy both as to what it shall include and what the amount should be. It is a fund set aside each year from the income to provide for replacing any part of the plant that may become worn out or out of date, or that has to be replaced for any other reason. As already mentioned, it may also be drawn upon for any additions or improvements that may be required in order to meet competition or some other change in the conditions, where such extra expense does not result in increased net profit. The amount that it will be wise to lay aside for this purpose will depend much on the conditions of each case, and will vary widely for different plants and different localities.

Under administration charges may be included the purely financial and commercial features, such as accounting, canvassing, collecting, etc., features on which no good business man should need advice from an engineer.

INCOME

Show the average man a stream sliding down a steep declivity with its evidence of power, and he will wonder why some one has not utilized all this energy instead of allowing it to run to waste. If it be some lonely mountain stream, he will return to civilization with glowing accounts of a magnificent water-power he has discovered, whose location must be kept secret for fear some other enterprising business man may step in and reap the rewards of his perspicacity.

In time he learns that the utilization of this water-power means the spending of money, possibly of a very large amount of it; if he be wise, he will consult some engineering friend with experience in such things.

"What market is there for the power in the immediate vicinity?" Market, forsooth! Will not manufacturers, users of power, jump at the chance of moving their factories to a place where power, that prime requisite of all modern production, can be had at a merely nominal cost? Alas! they will not, unless there be also other attractions,—abundant raw material near at hand, cheap and efficient labour, and low transportation rates,—a combination rare indeed.

Even when all these favouring factors are present, hard and persistent work will have to be done before a market for the full capacity of the plant can be created. Manufacturers who are making money in one location will generally prefer to let well enough alone, and those who are losing money find it difficult to raise the money needed for transplanting their factories.

In most business enterprises the business man first sees the demand, then tries to meet it. In the matter of utilizing water-power the process is often reversed; he sees the supply and then tries to find or create the demand. The method is faulty. Even if the power were offered to a manufacturer entirely free of cost, the cases are rare where he would be justified in moving for this reason alone. The ratio that the cost of power bears to the other factors in the cost of a finished product is usually very small, the cost of either raw material, labour, or transportation being in general of far greater importance. Unless, then, cheap and abundant raw material, a good labour market, and reasonable transportation rates can be also assured, no water-power, however inexpensive its development may be, can be considered a good investment unless a demand already exists for all the power it can furnish. It is clearly, then, of prime importance that either a demand for the power already exists or that the conditions are such that it can or will be created.

Now comes the most difficult and uncertain part of the problem. What is the highest price that can reasonably be asked per horse-power per year? At first sight the answer to this seems simple. Learn the price of coal and labour in the region where the power is to be sold; calculate by methods well known to engineers, the probable cost of steam power, and then offer your power at a figure enough below this to make it attractive to the consumer. This seems very reasonable; but, unfortunately, difficulties arise in applying this method in practice. It may be safely said that not one steam-power user in a hundred knows what his power really costs. Most of them will estimate it from one-half to two-thirds of its real cost, and cannot be persuaded that their estimate of its cost is too low.

Again, the power user in adopting the new power must either sell his steam-power plant for very much less than it cost him or must keep it, with the investment it represents, lying idle, and he must, in addition, invest in electric motors, since the power company generally delivers the power only in the form of an electric current at its premises, leaving him to install the necessary apparatus with which to utilize it. The quality of inertia inherent in human nature, causing opposition to innovation, must also be reckoned with. In view of these things, the safest course is to carefully canvass the region through which the power is to be sold and learn beforehand how much power can be sold and at what prices.

In this connection it must be understood that the sum of the capacities of the consuming motors may, under ordinary conditions, be much greater

than the rated capacity of the power plant, for the reason that all the motors will never be consuming power at their rated capacity at any one time. Moreover, a water-power plant always has a certain capacity for overloads for short periods of time that will furnish the excess power required when an unusual number of motors happen to demand a heavy current at one time. Thus it is possible to contract to furnish power for an aggregate capacity in motors much in excess of the maximum capacity of the power plant.

Where current is furnished for both light and power, the heaviest load will usually come on at dusk in winter when a lighting load is added to the day motor load. This condition, however, lasts for only a short period, as the motors are soon shut down, leaving simply the lights to be supplied. The variation of the load is different for every plant, and the conditions have to be carefully studied in order to determine just how much excess motor capacity is allowable.

In general, the larger the number of customers supplied and the smaller the average capacity of the motors, the greater may be the excess capacity of motors contracted for. Incidentally, since the cost of power per horse-power is much greater in small steam plants than in large, a much higher charge can be made for power supplied in small units. Further, the larger the number of customers, the less is the variation in income by the loss of one or more customers. In short, it is desirable, from almost every point of view, to supply as many customers in as small units as may be practicable. The supplying of lights in addition to power is also a great help, since the necessary extra expense is slight compared with the extra income secured.

The distance to which power can be transmitted at a profit depends upon the price that can be obtained and the cost of transmission. This cost of transmission increases very rapidly as the distance increases, and the limit is soon reached when the interest on the cost of the transmission line will raise the cost of the power supplied nearly to an equality with the price that can be obtained for it. In some localities, where coal is poor and costly and steam power consequently expensive, it has been found feasible to transmit power at a profit over comparatively very long distances,—in one case 225 miles. Where good coal is cheap and abundant, 25 miles are about the limit to which power can usually be profitably transmitted.

Water Power Development in Canada

By SIR WILLIAM HENRY WHITE

Sir William Henry White, past president of the Institution of Civil Engineers, contributes to the recently published volume of the "Proceedings" of the Institution valuable data concerning the visit of a body of its members to the United States and Canada. Of special interest are the descriptions of important engineering works in Canada, particularly the development of water powers, and from that portion of the address the following extracts have been made.—The Editor.

GREAT schemes for the development of the natural resources of the Dominion are in progress and in contemplation. These include the construction of a transcontinental railway and of other new and important railway communications, the development of the waterways between the Great Lakes and the Atlantic, fuller utilization of numerous sources of water power for industrial purposes and for the production of electrical energy, as well as many other methods of increasing and transporting the natural products and the growing manufactures of this marvelous country. No engineer who visits Canada can fail to be impressed by the enterprise and courage with which the Government and private associations are facing these and other great problems, upon the solution of which depends the making of a nation. When it is remembered that the total population of Canada, with its immense extent and wonderful possibilities, is only about 5,500,000 people, the scale and cost of these great engineering works seem even more remarkable. It is a fact of which we may be proud that British capital has much to do with these undertakings and it may be hoped that it will occupy the first place.

The extent of the shipping and trade of the lakes is hardly realized here, or the importance attaching to possession of traffic from the lakes to the open sea. On the other side this is well understood, and the competition is keen between the United States and Canada. On the improvement of the Erie Canal it is proposed by the United States to spend about $100,000,000. The Canadian Government, about the time of our visit, decided to spend £50,000 on surveys and investigations as to the probable cost of making a new waterway 22 feet deep from Georgian Bay, on Lake Huron, by the Ottawa River, to Montreal. This would be the shortest distance (425 miles) from the lakes to Montreal, the port lying farthest up the St. Lawrence to which ocean-going ships proceed. By existing routes the shortest distance from Sault Ste. Marie to Montreal is 950 miles; the new canal would reduce this to 610 miles. The magnitude of the shipping passing through the canals at Sault Ste. Marie may be judged from the statement that so long ago as 1889 the aggregate tonnage approached 7,250,000 tons and exceeded the corresponding tonnage for the Suez Canal by nearly 500,000 tons, although the navigation was open only 234 days in the year. In 1903 the traffic rose to 14,000 vessels of 27,750,000 tons and in 1904 to 12,200 vessels of nearly 24,500,000 tons. The Canadian authorities are clearly well advised in endeavoring to improve the communication of such a traffic with the sea via the St. Lawrence, and the results of the surveys of the Georgian Canal will be awaited with interest.

The Soulanges Canal, which we visited, forms part of the St. Lawrence navigation. It is 14 miles long and has five locks, with a total rise of 84 feet. The locks are 280 x 45 feet, with 15 feet of water on the sills. The locks and sluice gate mechanism are operated by electric motors, and the locks can be filled in five or six minutes, through cast iron pipes 30 inches in diameter, passing through culverts in the side walls. The breadth of the canal at the bottom is 100 feet and at the water surface 164 feet. About £1,350,000 has been spent upon its construction and equipment. The electrical equipment is worked by water power, the head being 20 feet; the total output is about 530 KW. The canal is lit by 219 arc lamps of 2000 CP., placed 480 feet apart, so that the navigation proceeds night and day. Electric power is also used to operate locks and bridges. There are seven bridges of 180-feet span, each weighing about 100 tons.

Another work of which we had particulars given us was the Richelieu and Trent Canal, which will join Georgian Bay on Lake Huron to Lake Ontario. The route is about 200 miles long, about 20 miles being canal. It embraces a hydraulic lift lock 140 x 33 x 8 feet, the rise being 65 feet. The fundamental idea of the promoters is to bring grain and other freight in large lake steamers to Georgian Bay, then to tranship into bridges of considerable size,

which will pass through the canal to a sheltered port on Lake Ontario, from which place groups of barges would be towed to Montreal and their cargoes transferred to ocean-going ships.

As to the St. Lawrence itself, the navigable channel to Montreal for large ships has a minimum width of 300 feet, extending to 550 feet at the curves, and it is expected that a depth of 30 feet throughout will be obtained next summer. Extensive works are also in progress for the improvement of the port and for increased accommodation for large ships. Montreal obviously intends if possible to maintain its position as the head of ocean navigation and the terminus of the great canal system.

CANADA RICH IN WATER POWERS

The resources of Canada in water powers are unsurpassed. Already large use has been made of them for the generation of electricity and for industrial purposes. What has been done as yet is only a commencement of a great development that will have far reaching consequences on the future of the Dominion. At Ottawa we visited the Chaudière Falls and the power houses of the Hull & Ottawa Power Company, the Ottawa Electric Company and the Ottawa Electric Railway, as well as the Ottawa Carbide Works, the Eddy Company's match, pulp and paper mills and Booth's lumber and pulp mills. No one could fail to realize the enormous possibilities of development in the pulp and paper industry, lumber being abundant and easily brought in rafts down the river to the mills, power cheap and a good supply of labor available. There is at present a great export of pulp to paper mills in the United States, but Canadians are not slow to realize that paper rather than pulp should be their main product. We were informed that within a few miles of Ottawa there are 200,000 H. P. of water power and within a radius of 45 miles nearly 1,000,000 H. P.

Outside Quebec, at the famous Falls of Montmorency, we visited another interesting electricity generating station. The falls are nearly 270 feet in height, the head utilized being 200 feet. Five turbines are installed, each of 1000 H. P., and the current is employed in electric traction on the Quebec Railway and for lighting.

An excursion was made to the Shawinigan Falls from Montreal. The falls are about 150 feet high and the water power is estimated to be sufficient to produce upward of 100,000 H. P. Here water is taken out of the river by a canal 1100 feet long, 100 feet wide and 20 feet deep. In the power house there are installed 3 pairs of inward discharge turbines, each pair (at 180 revolutions per minute) being capable of delivering 6000 H. P. A fourth unit was being installed and will be capable of delivering 10,500 H. P. The electric energy is utilized in factories 2 to 20 miles distant and in Montreal, 85 miles away. At the latter city 6000 H. P. is now being delivered at a pressure of 50,000 volts. Among the industries obtaining power from these falls are electric lighting and traction, the manufacture of calcium carbide and ferromanganese and pulp mills. Linen mills are to follow. Within four years of the time when the Shawinigan Falls were accessible only by canoe they have been thus utilized and made readily accessible, with a population in the district of 3000 people.

POWER FROM NIAGARA

To the Niagara Falls Hydraulic Company belongs the honor of having made a systematic and large scale attempt to utilize the power of the falls about 50 years ago. No practical result was attained until 1870, and only in 1881 was the supply of electricity undertaken by means of three water wheels under a head of 75 feet, developing 1500 H. P. In 1895-1896 a second power house was erected, placed near the water's edge in the gorge and utilizing the full head of 210 feet. Subsequent additions have raised the total development of this power house to nearly 35,000 H. P.; now a third power house is in hand to give additional development of 100,000 H. P.

The Niagara Falls Power Company, also on the American side, began its preparatory work in October, 1890, and commenced actual work about five years later. An international commission, including Lord Kelvin and Professor Unwin, who was one of our party, was appointed to settle the general plan of the works. On its advice the turbines were placed in a wheel pit about 425 feet long, 18 feet wide and nearly 180 feet deep. They work under a head of 136 feet. The generators are placed on the surface and are driven by vertical shafts formed of sheet steel between the bearings. There are 10 units in the first power house constructed, the aggregate development being about 50,000 H. P. A second power house has since been constructed on the same general lines with 11 units. At the present time, therefore, this company is capable of developing about 105,000 H. P., of which 60 per cent. is utilized in local industries at Niagara Falls and 40 per cent. at Buffalo and other places, some of which are 35 miles distant. The transmission is effected at a pressure of 22,000 volts. Power is supplied to more than 100 factories, which are engaged in many branches of the electro-chemical industry, in electric traction and lighting, milling, iron and steel manufacture, mechanical engineering and other work. One of the new companies on the Canadian side is really an extension of this American enterprise and will add 110,000 H. P. to its output when complete.

On the Canadian side a concession was granted in 1892, but nothing was done until 1901. Three new undertakings are now being rapidly advanced and the works were in a condition that permitted an inspection of nearly all their details. No one visiting them can fail to be impressed by the grand scale and the enormous expenditure necessary to utilize the water power, as well as the large demands made in their execution upon branches of engineering other than the purely electrical. Two of the three companies are following in principle the system of the American Niagara Power Company—placing the turbines in wheel pits 150 to 165 feet in depth—the generators being placed in power houses at the ground level. The aggregate development in both establishments will be 235,000 H. P. The Ontario Power Company, on the other hand, follows the example of the earliest American company. The power house is placed in the gorge. About 180,000 H. P. represents the power to be developed eventually, but at present only one of the 3 conduits is being laid underground from the head works near Dufferin Islands to the power house. The conduit is nearly 6200 feet in length and 18 feet in internal diameter; it is built of ½-inch steel plates and stiffened on the upper half of its circumference by 7-inch T-bulbs spaced 4 feet apart.

The aggregate development of these three works when completed will amount to more than 400,000 H. P. and a fourth establishment on the Canadian side will develop 40,000 H. P., which will be utilized chiefly in the city of Hamilton. The grand total of power derived from the Niagara River will then be about 700,000 H. P., two-thirds being on the Canadian side.

THE ELECTRICAL AGE

Volume XXXV Number 5
$2.50 a year ; 25 cents a copy

New York, November, 1905

The Electrical Age Co.
New York and London

ESTABLISHED 1883

Published monthly at 3, 5 and 7 W. 29th Street, New York City.

Telephone No. 1617 and 1618 Madison Square. Private branch exchange connecting all departments. Cable Address—Revolvable, New York.

SUBSCRIPTION RATES

The Electrical Age will be sent post free anywhere in the United States and its possessions, Canada and Mexico for $2.50 per year, single copies 25 cents. To Great Britain and all countries embraced in the postal union, $5.00, 20 shillings, 25 francs, 20 marks, or 15 rupees. Send subscriptions to our nearest branch office or agency.

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Insertion of new advertisements or changes of copy cannot be guaranteed for the following issue if received later than the 15th of each month.

LONDON OFFICES

Business Department, 33, Bedford Street. Editorial Department, 22, Henrietta Street. Covent Garden, Strand, W. C.

London Telephone, Post Office, 3807 Central. Private branch exchange. London Cable Address—Revolvable, London.

All remittances to London Office should be crossed London and County Banking Company.

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The Efficiency of Telephone Service

THE development of the telephone business within the past few years illustrates a perfecting of details unsurpassed in any other branch of electrical industry. The central office of to-day bears no more resemblance to that of ten years ago than the Pacific type of locomotive does to the red-funnelled wood burner of the seventies; the modern conduit system exhibits far better mechanical designs than the early underground routes exemplified; line construction has become an engineering problem instead of a bell hanger's job out-of-doors; and instruments for home and office use have been developed into remarkably compact and efficient mechanisms. To the subscriber these improvements have in the main appeared in the form of better service, but quite apart from the evolution in equipment, the influence of better organization in the operating department has been in large measure responsible for the efficiency of the modern telephone system.

The extent to which this perfecting of organization in the traffic department has been carried is little realized outside of telephone circles. Uniformity of service has naturally been emphasized with greater effect by the constituent Bell companies than by the independents, but all along the line the importance of proper training for operators is now thoroughly appreciated. Progressive managers the country over are studying their traffic as probably never before; peg counts are regularly taken in the central office to show its volume and distribution of calls on an hourly basis at all switchboard positions; and constant daily inspection of the service by monitors and other expert operators provides for the re-distribution of subscribers' lines to better conserve prompt reply to incoming calls, speedy establishment of local and trunk connections, team work and the even loading of individual operators. Great care is being taken to insure correct enunciation in accord with the company's standard methods, and in general the training impressed upon operators is now calculated to make them uniformly courteous to subscribers, expert in manipulation, and cool-headed in times of emergency. More than this, the companies have done much to educate subscribers in the correct methods of using the telephone, with most gratifying results.

Although it is difficult to forecast improvements in telephone apparatus, it is certain that in many instances even better service can be given with the existing equipment. Skilled operators can handle an old magnetic switchboard to the better satisfaction of subscribers than poor operators with the most modern central energy lamp signal outfits. In order that the service shall be excellent, it is necessary that operators respond within 3 or 4 seconds after receiving the calling signal; that the desired numbers shall be repeated distinctly to the subscriber; that operators shall use both hands with equal facility in plugging into jacks, ringing, taking down connections, etc.; that supervisory signals from subscribers shall be answered promptly—and the neglect of this is one of the most common faults of the present day; that cut-offs shall not occur, and that adjacent operators shall help each other in the handling of all calls within reach, which is team work.

A great deal of time is often lost when a subscriber is given the wrong number, in the effort to re-establish communication. The delay of the operator in taking down the wrong connection and in answering the subscriber's supervisory signal leads to endless annoyance at times, even in large city exchanges where the value of time is appreciated.

The private branch exchange represents the climax of telephone development, and its extension in the large cities of America during the last few years has been phenomenal. It is primarily a labour and a time-saving device, and upon the quality of service rendered by the operator in charge depends both the reputation of the house in which it is established, and the exchange service as a whole. Too much care cannot be taken to select an experienced operator in all cases where the volume of traffic is sufficient to demand con-

stant attention. The highest operating efficiency requires the quickest possible establishment of connections between the two persons who desire to converse, and also the same expedition in the removal of connections when the conversation is finished. Speedy response to signals is even more important than in the central office, on account of the heavier traffic per wire found in private branch exchange trunks than in ordinary subscribers' lines.

The custom of turning calls over to one's private operator and then attending to other business until the desired party is at the other end of the line is open to serious objections on account of its effect upon the service as a whole, convenient as it is to the calling subscriber. If the private operator is very busy, the called party is likely to be subjected to vexatious delays, and if the extreme is reached, where neither party will come to the telephone until the other is on the wire, a deadlock results, and the trunk line is tied up to the great disadvantage of every one concerned. The necessity of the foregoing practice grows out of the quality of service given in the exchange as a whole, and if the traffic is handled with the utmost skill which modern conditions of operation permit, there is little or no occasion for delays of this character. In any event, the practice of turning over calls to a subordinate should be permitted only in the case of department heads and officials of greater rank.

It is obvious that the efforts of the best equipped and most highly trained central office will come to naught if the subscribers do not cooperate in prompt calling and answering. If the telephone is left before the conversation has been concluded, the operator cannot be blamed for taking down the connection. In times of emergency the central office is often able to cooperate with the subscriber to his personal advantage, thanks to the organization of the switchboard force. Thus, a physician's services may be needed at the earliest possible moment, and the calling subscriber has no time to spend in looking up in the directory the numbers of the neighbouring doctors. A progressive company will in such cases instruct the operator concerned to devote all her time to the putting-through of calls, and in critical hours the saving of several minutes in this way is liable to be of immense importance.

Imperfect though modern telephone service sometimes appears to the hard-pressed subscriber, it is cause for appreciation that the handling of traffic is constantly receiving the analytical study of experts. From the American standpoint the value of a commodity is measured by its quality as well as its cost, and in the exigencies of modern business life the saving of time is often worth double or treble the nominal price charged for a given service. No one can estimate with any accuracy the business stagnation which would result from the elimination of the telephone from present-day affairs. Unsatisfactory as are the conditions at times for the easy transaction of business over the telephone, the fact that most companies are always trying to improve their service should not be overlooked, and the high efficiency of the modern telephone system should be constantly realized by fault-finding subscribers.

Cheaper Alcohol for Industrial Use

RENEWED efforts are to be made before Congress to give the users of domestic alcohol for industrial purposes in this country the same exemption from internal revenue taxation that is granted in foreign countries. The enactment of a bill to that effect would provide an abundant supply of desirable internal combustion motor fuel, at a price as low as, if not lower than, the cost of gasolene.

The benefits which would result from such legislation are so manifest that its adoption should be urged by every manufacturer or user of automobiles, power launches, or motor engines of any kind. The measure has absolutely no connection with the question of the importation of foreign alcohol. It is not intended to interfere in any way with the present duty on imported alcohol. The material which it is proposed to free from the present excessive internal revenue tax is alcohol made in this country from materials grown by our farmers, which has been rendered unfit for use as a beverage.

The chief obstacle to the proposed legislative measures is the opposition of the wood alcohol interests, who are now enabled to sell their inferior product at a large profit by reason of the fact that it is not taxed. These interests are antagonistic on the ground that their industry will be injured by the proposed measures. In other words, they ask Congress to continue a tax of $2.08 per gallon of commercial alcohol on the product of corn raised by our farmers when used for industrial purposes, while allowing their product, used for the same purpose, to go untaxed.

A special reason why the plea of the wood alcohol interests for the continuance of the tax on domestic ethyl alcohol should not be regarded is the fact that large areas of forest are destroyed in the process of manufacturing the eight or ten million gallons of wood alcohol now used annually. Certainly there would seem to be no justification for a policy which encourages the wasteful destruction of forests for use in producing a substance which is greatly inferior to, and much dearer than, a similar substance procurable in unlimited quantities from farm products.

The Electrification of the New Haven Railroad

CONCERNING the proposed electrification of the New York division of the New York, New Haven & Hartford Railroad, already referred to at some length in these pages last month and further dwelt upon elsewhere in this issue in Charles F. Scott's paper entitled "The Single-Phase Railway System" —and as well in a brief summary of a protest against that system on that line by Frank J. Sprague,—on page 399,—William S. Murray, electrical engineer of the New Haven road, writes as follows:—

"It is interesting to note the unsolicited general concordance of opinion on the part of certain engineers, and gratifying in the main to note temerity in expressing a concrete opinion of our decision.

"Without a full appreciation of the relevant factors in the case, one could hardly view with a more kindly eye a hearty endorsement of our conclusion than a condemnation of it. Certainly the first indication of a real engineer is his reservation of an opinion until all these relevant factors have, in the full knowledge of their true bearing, been assembled. To-day a conclusion is worth nothing that is not a compromise. A compromise is the true algebraic sum of all the relevant factors.

"After six months of careful study of the possible methods of electrification a conclusion has been reached. The work has been too initiative, the ground too new, and the opportunity too exceptional not to have kept an accurate log upon the method of procedure. Were it possible to devote time to things other than an expeditious and careful continuance of the work begun, we would gladly segregate this conclusion into its relevant factors and discuss it with those engineers who by the reserva-

tion of their concrete opinion have shown a silent wish to later agree or disagree with its plans.

"To the two great electrical manufacturing companies who have placed the genius of their engineering in our hands for consideration we have nothing but the highest tribute to pay. It has been no mean privilege to make a minute study of their individual viewpoint of the problem. It is true, their analysis of the situation has dictated widely separated conclusions, and those engineers who appreciate the trust imposed in this decision for the New Haven road can readily understand that the divergence of opinion has served only to double the responsibility of the conclusion, but by which the engineers for the New Haven road are in no way disturbed.

"To those minds prone to a conclusion without the assistance of the relevant factors it may be a helping thought to say that, throughout the study of the New Haven's electrification the Central's plans have been a constant and most relevant factor. The conditions of the New Haven problem, however, are widely different. It has been deemed that alternating current is pertinent to their proper fulfillment. Because the New Haven locomotives will be operative either on direct or alternating current in no way emphasizes the importance of their interchangeability. The condition imposed in effect makes valuable the double characteristic. A criticism of the Central's plans is irrelevant and unnecessary; direct-current propulsion is the judgment of their engineers. Our concern is its effect upon us, and it is read in the direct characteristic of our locomotive."

The prizes offered by "Engineering News" and "The Cement Age" of New York, for the best papers on "The Manufacture of Concrete Blocks and Their Use in Building Construction," were recently awarded by the jury, which was composed of Messrs. Robert W. Lesley, past-president of the American Cement Manufacturers' Association; Richard L. Humphrey, president of the Cement Users' Association, and Prof. Edgar Marburg, secretary of the American Society of Testing Materials. The first prize of $250 was won by a paper by H. C. Rice, of Denver, Col., secretary of the American Hydraulic Stone Company. The second prize of $100 is given to a paper by Wm. M. Torrance, C. E., of New York City, assistant engineer in charge of concrete-steel design for the Hudson Tunnel Companies.

The American Society of Mechanical Engineers

THE annual meeting of the American Society of Mechanical Engineers will be held in New York City during the first week in December. The headquarters, instead of being at the Society House, 12 West Thirty-first street, as in previous years, will be at the Edison Building, 44 West Twenty-seventh street, two upper floors being used.

The opening session, at which President John R. Freeman will present the annual address, will be at 44 West Twenty-seventh street on Tuesday evening, December 5.

The second, or business session, will be held on Wednesday morning, in the main saloon of the steamship "Amerika," at the docks of the Hamburg-American Line at Hoboken, N. J. Following this session a special train will take those desiring to make the excursion to the new Henry R. Worthington Hydraulic Works, at Harrison, N. J.

Wednesday evening there will be an illustrated lecture at 44 West Twenty-seventh street by Prof. R. W. Wood, of Johns Hopkins University, on "Photography of Invisible Phenomena." The third session will be on Thursday morning at 44 West Twenty-seventh street, and besides the presentation of professional papers there will be a discussion on the subject of Bearings. On Thursday afternoon there will be a reception at the New York School of Automobile Engineers, 146 West Fifty-sixth street.

The usual reception at Sherry's will occur on Thursday evening. The closing session will be at 44 West Twenty-seventh street on Friday morning, and will be devoted to the presentation of professional papers.

One Year's Operation of the New York Subway

ON October 27, the New York Subway completed its first year of active service, and the statistics of travel and the verdict of the public agree in pronouncing this great engineering work, with one exception, a complete success. During the twelve months, according to the "Scientific American," 106,000,000 passengers have been carried, at the average rate of about 300,000 per day. The total number of passengers carried daily on the elevated roads works out at an average of about 717,000 per day, so that a reasonable estimate of the number of passengers carried by the elevated and subway combined amounts to over 1,000,000 per day.

The figures for the subway are the more remarkable when it is borne in mind that only a portion of it has been in active operation for the whole twelve months. The Lenox avenue branch to West Farms, the section from the Brooklyn Bridge to the South Ferry, and about a mile of road north of 135th street on the Broadway branch, have been in operation only for a portion of the year. The company expects to open the road from 157th street to the Harlem Ship Canal by January 1, and next year also the important Brooklyn branch from South Ferry to Flatbush and Atlantic avenues will be put in service. It is reasonable to expect that with these important additions, the total daily travel will average 400,000 per day for the year.

It is not often that a great public improvement in transportation such as this scores such a large and immediate success, running far beyond the preliminary estimates of its usefulness. Save for some confusion in the first few days of operation, due to limited switching accommodation at the terminals, and to the restraining hand laid upon the traffic by the excellent system of block signals on the express tracks, there has been but little interruption to the steady flow of travel. This, however, quickly passed away, and the system has been running day and night, for many months, with an absolutely clocklike precision. The speeds, particularly of the express trains, have been rather over than under the estimate, and the new steel cars, introduced for the first time on this road, have been an unqualified succeess, running with the smoothness of a Pullman car, and coming through such collisions as have occurred, in a way that proves them to be an excellent protection to the life and limb of the passengers.

The first steps have, says the London "Times" engineering supplement, been taken by the managers of the Austrian State Railways to electrify a large section of the system. This consists of a scheme for the introduction of electric traction on the Upper Austrian, Salzburg, Tyrolese and other Alpine lines, as also on the Tauern Railway, now in course of construction, of which mention has recently been made. For this purpose the abundant and ample water-power in the Alpine regions has been secured by the railway authorities, as also on the river Salza, near Golling, in the Salzburg area.

The Single-Phase Railway System

By CHARLES F. SCOTT, Chief Electrician of the Westinghouse Electric & Manufacturing Company

A Paper Read Last September Before the American Street Railway Association

It is the purpose of this paper to present some of the salient features of the single-phase railway system, and the results of the work which has been accomplished in the development of apparatus to meet the increasing demands in electric traction.

The questions which a railway manager is apt to raise with regard to the single-phase railway concern is its suitability for his particular conditions, its present practical status and its cost. The answers which apply in one case may be misleading in others, so that the discussion of the subject must be general rather than particular.

There are two other questions which have been asked so often that they deserve a passing comment: Will the motor start with good torque and accelerate rapidly? Will it commutate? Suffice it to say that the single-phase motor of the variety which I am considering does start and accelerate and commutate.

It is not the motor itself, but the single-phase system which the motor makes possible that is of prime importance. And the system is of commercial value only as it is able to operate electric railway service more effectively and economically than is practicable by other means.

SINGLE-PHASE AND DIRECT-CURRENT SYSTEMS COMPARED

The single-phase system accomplishes the same results in car movement that may be obtained by direct-current equipments, but in many cases with less first cost, less operating expenses, increased flexibility and greater simplicity.

The radical difference between railway systems using direct-current motors and those using single-phase motors is not so much in the car or the power house as it is in the circuits connecting them. In the first place, the high voltage used on the trolley wire does away with expensive feeders, and it also enables the current to be carried to a greater distance from the power house or from the sub-station. Second, the sub-station employed in the single-phase system requires simply a lowering transformer. The sub-station for supplying a direct-current railway requires the rotary converter and a set of lowering transformers. Third, the number of sub-stations for a single-phase road is less than is required for direct current, and these do not require the attendance which is necessary for the operation of rotary converters. It is these characteristics that peculiarly adapt the single-phase system to interurban and long-distance railways.

CONSTITUENT PARTS OF SINGLE-PHASE SYSTEM

The motor is the feature which has received particular interest and comment, for it has been conceded that if a single-phase motor be available the other elements would follow as a matter of course. No one has questioned the adaptability of control apparatus, transformers and high-tension line construction to the requirements of the single-phase railway system. This simply involves the application of well-known apparatus and methods to the particular requirements of railway operation. But a perfected motor does not mark the completion of development work. Control apparatus for handling alternating current must be devised and constructed. It must be suitable for hand control for small cars, and it must be adapted for the multiple-unit operation of heavier equipments. Still other forms must be suitable for operation interchangeably on either direct or alternating current. Transformers, line switches and other auxiliaries must all be combined into a workable equipment. Forms of trolley and overhead construction must be developed suitable for the new conditions of current and voltage. The announcement of a commercial single-phase motor, made in the paper of Mr. Lamme before the American Institute of Electrical Engineers three years ago this September, was necessarily the beginning rather than the end of the development of the system as a whole in all its details.

ADVANTAGES PROVED BY SERVICE

In how far have the advantages claimed for the single-phase system been realized? Among the important features are the following:—

A high-voltage trolley construction has been developed and has proved to be simple, strong and thoroughly practicable. Thirty-three hundred volts have been used and have proved to be safe and reliable.

A sliding contact device which does not require reversing when the direction of the car is changed is found more satisfactory, especially for high-speed operation, than the trolley wheel. Its wearing surface lasts longer than trolley wheels operating lighter cars on direct current.

Transformer sub-stations supply current satisfactorily without feeders and without station attendants.

The car equipments show simplicity and effectiveness in the control apparatus. Less than half the controller notches required for direct current give equally smooth and as rapid acceleration with alternating current. Platform controllers are simpler, as no magnetic blow-out is required. The multiple-unit control system is readily adapted for the operation of single-phase motors, and is in some points simpler than the control of direct-current motors.

The operation interchangeably by alternating current and by direct current is a feature of an important road which operates large equipments on direct current in the city and on alternating current across country.

Motors of four or five sizes have been built and show excellent commutating features. The commutators take a good polish. The motor windings are such that there is a practically balanced magnetic pull, even if the armature be slightly out of center. Although the armature speed is higher than in corresponding direct-current motors, the advance criticism has proved ill founded, as there have been no bearing troubles. The oil lubrication has proved highly satisfactory.

The foregoing features, which are the important elements upon which the claims of the single-phase system are based, have been shown by actual operation to be entirely feasible and profitable, and such as to inspire confidence.

Difficulties have been met which have been annoying and vexatious. The difficulties, however, have usually been due to some error in the general engineering features or to some specific point of weakness in the insulation or construction of some part of the apparatus. In other words, the troubles have not been fundamental and inherent in the single-phase system, but have been incidental and capable of ready remedy. Some particular difficulties will be taken up further on in this paper.

LEADING FEATURES OF THE SINGLE-PHASE SYSTEM

As a guide to determine the conditions under which the adoption of the single-phase system is advantageous it will be useful to review briefly some of its features which are particularly concerned in its installation and operation.

The motor.—A motor which is protected from the trolley voltage and lightning disturbances by an intervening transformer winding, which has only 200 to 250 volts across its terminals, which may have its brushes grounded or short circuited without "flashing" or "bucking," and which may have full voltage thrown on its terminals without disaster to itself, is essentially a safe motor. The armature has a bar winding on sizes of 30 H. P. and upward. The increased current required at low voltage necessitates brush capacity equivalent to that on a direct-current motor of twice the output.

The control.—One usually thinks of the direct-current street railway motor as a variable-speed motor. Yet it is, in a sense, fundamentally a one-speed motor, for with definite trolley voltage, weight of car and grade, the motor soon attains a definite speed, at which it continues to run until there is a change either in the voltage applied or in the load. If two motors be operated in series there is a second definite speed, which is about half of the speed when they are in parallel. Other speeds are obtained by lowering the voltage on the motor by means of resistance, but this is inefficient and is admissible only in starting.

Certain results follow. The speed of the car depends upon the trolley voltage. If the voltage be low, the speed is low. The efficient speeds are fixed by the trolley pressure and not by the motorman. The relation between speed on level and the speed on grade is fixed by the inherent characteristics of the motor. A given motor with definite gear ratio has its one definite speed depending upon train resistance and electromotive-force. There is no range of adjustment like the throttling of an engine without the introduction of the wasteful rheostat. In a series motor the current determines the torque, and the electromotive-force determines the speed. Hence, for speed control there must be voltage control. In the direct-current system efficient voltage control is not attainable, but with alternating current it is easily secured. The simplest method of variable voltage is by means of taps from the transformer winding. The low voltage required for starting is obtained from a low tap, and the successively higher voltages for increasing speeds are secured from successively higher taps from the winding. As there is no rheostat, the motor may run efficiently from any tap, thereby giving the motorman a control over his car movement which is not possible with direct current. If there be a tap giving a voltage higher than that required for normal running, it is available for giving a higher speed for making up lost time, or for supplying normal voltage to the motor when the line pressure is low. The car can run at any time at the pressure needed.

The number of points required on the controller for smooth acceleration is much less with alternating than with direct current. The whole control system, in fact, is simply half a dozen taps from the transformer to the controller, by means of which any one of them may be connected to the motor. An intervening preventive coil enables the controller to pass one point to the next without opening the circuit or short circuiting the two taps. The controller may consist of a drum of ordinary form on the car platform or of unit switches placed under the car and operated by a master controller. The latter type is used in heavy equipments and also when several cars are to be operated in the multiple-unit system. An effective form of switch with magnetic blow-out has been developed for heavy currents. The switches are assembled in a compact group, thoroughly protected and easily accessible.

Trolley voltage.—Twenty years ago the electric railways of the United States, as measured either in miles, in cars or in kilowatts, comprised less than 1 per cent. of what they do to-day. In this enormously rapid growth two features of the electric railway have remained unchanged, although other elements have been greatly modified. These two features are: First, the series motor; second, the use of direct current at approximately 500 volts. During this time the generating plant has changed from small belt-driven to large direct-connected units, and then from direct current to alternating current. High-tension transmission circuits with rotary converter sub-stations have been common. Motors have increased in size and have been improved in design and in reliability and the multiple-unit system of control has been introduced for larger equipments. The trolley voltage, however, has been limited to approximately 500 volts on account of the limitations of the direct-current motor and the inability to transform direct current on the car from a high voltage to a low voltage. The general trend of electrical engineering has been toward alternating current at high voltage. Many can remember the time when the use of 1000 or 2000 volts was decried as impracticable or unsafe, and when 5000 or 10,000 volts was the limit to laboratory experiments. Progress has been made in design, in construction and in materials until voltages, which not long since were impracticable, are now operated with greater reliability and safety than were the lower pressures a few years ago. Safety is very largely a question of mechanical excellence. In railway motors and control apparatus, in the mechanical equipment of heavy and high-speed cars, in overhead construction and in power house equipment, reliability is primarily dependent upon mechanical excellence.

While any considerable increase in voltage may not be safe on existing trolley lines, it is practicable by an increase in mechanical strength to offset the higher pressure and produce a high-voltage trolley system of greater reliability and safety than the present construction for low voltage affords. Such a construction has been developed into a commercial form in the catenary suspension of the trolley wire. An auxiliary steel cable with a moderate sag at the center of spans supports at frequent intervals the trolley wire which is thereby maintained at a uniform height. It is adapted for high-speed running and it possesses a greatly increased strength. The excess cost of the catenary construction over the cost of poles and overhead construction of the ordinary type is moderate, and, in a large measure, is justified by the gain in mechanical reliability quite aside from the question of voltage.

The sub-station.—To one familiar with an ordinary rotary converter sub-station interest will center chiefly in the negative characteristics of the single-phase sub-station. There is no rotary converter—a most essential link in the old system, one which be-

haves remarkably well when all is favourable, but is inclined to be fussy and obstreperous when the conditions are not to its liking. There is no synchronizing, no sparking, no flashing, no dropping out of step. The transformers are not arranged in banks of two or three little ones, with polyphase switches and auxiliaries in primary and secondary, and the direct-current switchboard has disappeared entirely.

So much for what it is not. In its simplest form the sub-station is a single transformer with its primary and secondary connections. Additional transformers, switches, lightning protection and instruments are added as circumstances require.

Short circuits have lost much of their terror. The alternating current on short circuit is limited by the self-induction of the circuit, and a transformer is not disturbed by a "short" as is the commutator and the speed of a rotary converter.

The difference in the effect of a short circuit on direct current and on alternating current is well illustrated in the underground circuits in New York City. In an 11,000-volt cable system a fault in the cable causing a short circuit is usually confined within the cable and merely burns out a few inches of the conductor before the circuit-breaker opens. On a low-tension system, however, the currents are very large, and considerable lengths of the conductor may be melted before the current is interrupted. In an alternating-current system the normal current in a circuit delivering a given amount of power is less in proportion as the voltage is increased, and, as the increase of current above normal is not as great on account of the self-induction of the circuits and apparatus, accidents are less liable to be destructive.

OPERATION ON DIRECT CURRENT

If the single-phase road is to be an extension of an existing road, it may be desirable to run the single-phase cars over the tracks which have a direct-current trolley wire. While single-phase cars can be arranged to operate from a direct-current trolley wire, it handicaps in some measure the single-phase equipment. The addition of resistance to the car equipment and the extra switches and the like for enabling the change to be made in the current supply are obviously objectionable. It is best, therefore, to keep single-phase equipments free from operation on direct current if it be practicable to do so. When it is found necessary for them to operate from an existing direct-current trolley wire, the motors are connected two in series for 500 volts, and if there be four motors the two pairs may be connected first in series and then in parallel as in ordinary series parallel control. The transformer is cut out, and the control apparatus and motors operate in substantially the same way as those on an ordinary car.

SOURCE OF POWER

The standard frequency for the single-phase motor is 25 cycles (3000 alternations). Generators may be wound for single-phase, or current may be taken from one phase of a two-phase or a three-phase generator. Current from the several phases of a polyphase generator may be used for operating different divisions of the railway.

If power is to be taken from a power house which generates a higher frequency it cannot be applied directly, but must be changed to 25 cycles. This may be effected by a motor-generator set. A polyphase motor taking power equally from each phase of the high-frequency circuit may drive an alternator, either single-phase or polyphase, for furnishing current to the single-phase railway. The converting outfit may be located in the main power house or in a sub-station as may be found most convenient.

THE FIELD FOR SINGLE-PHASE RAILWAYS

The development of a new and more efficient method for accomplishing a given result often leads on and opens new fields which have not been commercially practicable before. Such is the case with the single-phase railway. The direct-current interurban railway has its limitations. If a region be sparsely settled the available traffic will not show a profit on the cost of circuits and rotary converter sub-stations. There is a material reduction in the investment and operating expense incident to the single-phase railway that will enable it to be built and operated with a profit in cases where the traffic would not support a rotary converter system.

On the other hand, in heavy service the direct current has not made much headway, being handicapped by the heavy cost of sub-stations and conductors. Heavy and relatively infrequent trains are the hardest loads for sub-stations. For example, if sub-stations be 8 miles apart, each will supply 8 miles of track. A train running 40 miles per hour will receive current from a given sub-station for 12 minutes. In order that a sub-station may be continuously supplying current to trains in one direction they must have a headway of 12 minutes. If they be an hour apart the current from each sub-station is used but one-fifth of the time. Trains in two directions will double the sub-station output, but as the peak load is considerable when two trains pass near a sub-station the load factor is extremely low. Therefore, as the aggregate capacity of the sub-stations must be large in proportion to the actual power taken by the cars, it follows that the sub-stations will involve a relatively large expense if they are equipped with expensive rotary converters and require constant attendance, whereas the cost will be relatively small if they require simply lowering transformers having an efficiency very much higher than the rotary converter sub-station and not requiring attendance. The reduction in the sub-station is therefore of especial value when the service is infrequent. Moreover, the single-phase equipment by reducing the size of conductors frequently enables the sub-stations to be more widely separated. This possibility in the reduction in the number of sub-stations and in the aggregate capacity of sub-station equipment, as well as the elimination of rotary converters with their energy losses and their attendants makes practicable the operation of long-distance roads which could be operated by direct current only at excessive cost.

The single-phase system therefore decreases the cost of installation and operation for the kind of interurban service which has been successfully developed by the direct current, and it extends the field of commercial operation to include, on the one hand, rural roads with relatively light traffic, and on the other, a heavy, infrequent, multiple-unit or locomotive service for passengers or for freight approximating steam railway conditions.

SINGLE-PHASE RAILWAYS IN OPERATION

The single-phase railway which shows the most extensive operation as measured in car-miles is the Indianapolis & Cincinnati Traction Company. Operation was begun over a short length of track January 1, and on April 1, 37 miles were covered. Since July 1 a regular schedule has been maintained over 41 miles, 37 miles of which is under alternating-current trolley and the remaining 4 miles is under direct-current trolley in the city of Indianapolis. The company has 10 cars, each equipped with four 75-H. P. motors. A maximum speed of 60 to 65 miles per hour is

secured, and the cars are not only the heaviest, but they operate upon the fastest schedule of any of the numerous suburban roads radiating from Indianapolis. Some defects have developed in the equipment, which, however, have been incidental in character, and not in those new features where trouble might reasonably have been anticipated. It was found that the natural ventilation under the car was insufficient for the transformer and a ventilating motor was added. A weak point developed in the armature insulation when the cars, which had been running for some time by alternating current, were first run regularly over the direct-current lines into Indianapolis. One feature of the new condition was the opening of the circuit with four motor in series, the motors having laminated fields which give greater field discharge than solid poles. The remedy was obviously the strengthening of the insulation. This brings out the interesting fact that operation on alternating current at 3300 volts with an intervening transformer is less severe upon the motor than operation on direct current at 500 volts. Experience showed wherein the control apparatus, suitable for both alternating and direct current, could be simplified and the apparatus reduced in quantity. The result is a control system which is relatively simple and compact, although suitable for operation interchangeably between alternating current and direct current.

The best verdict upon the working of the single-phase system on this road at Indianapolis has been given by the operating company. It is found in the contracts which have been placed for extending the present line a distance of 16 miles; also in extending the single-phase operation to the Shelbyville line, both to the 29 miles which have been operated by direct current and for a 20-mile extension. The length of track is therefore to be increased from about 40 to 100 miles; the number of cars will be double the present number and all equipments will be similar. It is significant that a company which has been operating two substantially similar suburban lines, one by single-phase current and the other by direct current, should see fit to throw out the direct current and substitute single-phase alternating current. It may be noted that this course was taken, although the reverse was easily possible, as provision was made in the original contract for the single-phase apparatus by which it would be exchanged for direct-current equipments if its operation proved unsatisfactory.

Other single-phase roads which are operating Westinghouse equipments show a variety of conditions, some having exceptionally sharp curves and steep grades. On the road between Derry and Latrobe, in Pennsylvania, 30-ton cars are started on a 10 per cent. grade. The cars have platform controllers and are equipped with four 50-H. P. motors. In some cases the initial operation has been handicapped on account of incompleteness, or through the use of temporary apparatus either in the power house or on the car. In its fundamental elements, however, the operation is proving perfectly satisfactory.

SOME NEW ROADS

The extension to long distances will soon be shown in the carrying out of the contract which has been closed by the Spokane & Inland Railway Company for 150 miles of railway running south from Spokane, Wash. The equipment will consist of fifteen motor passenger cars, each with four 100-H. P. motors; six motor freight cars, each with four 150-H. P. motors, and six 40-ton freight locomotives, which may be in pairs for heavy trains. The engineer of this road has been intimately connected with the installation and operation of the single-phase road at Indianapolis.

The most notable recent event in electric traction is the purchase of Westinghouse single-phase locomotives by the New York, New Haven & Hartford Railway Company. The passenger trains on this road which enter Grand Central Station in New York run over the tracks of the New York Central Railroad for about 12 miles. As steam locomotives cannot enter the new terminal station, and as the New York Central is equipping its track for direct current, it is imperative that the New Haven trains be handled over 12 miles by direct-current power. Instead of changing from electric to steam locomotives for all local and through trains at the end of 12 miles, it was decided to extend the electrification and to do it, not by extending the direct current, but by changing to alternating current. The single-phase locomotives will be designed so that they may operate interchangeably from direct current or from single-phase alternating current.

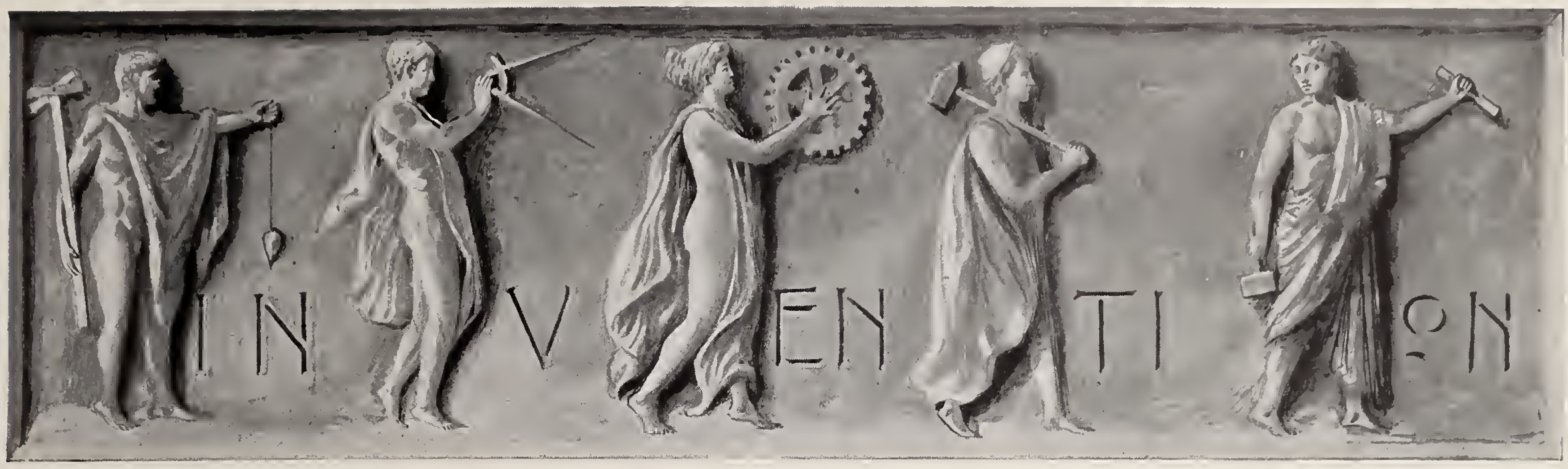
The adoption of the single-phase system by one of the leading railroads of the country for its heavy and important passenger service is all the more noticeable, first, because its officials are already familiar with electric traction matters through the operation of many important city and interurban railways in New England, and second, because the obvious thing to have done would have been to follow the example of the New York Central by adopting direct-current locomotives. Probably this is the turning point, and the coming electrification of heavy railways will follow the conspicuous example set by the New York, New Haven & Hartford Railroad Company in adopting the single-phase system.

Vestibuled Electric Cars

During the month of November one-third of the surface cars in the city of Brooklyn, N. Y., will be equipped with vestibules for the coming winter. The task of fitting the vestibules to the cars will be an arduous one on account of the different types of cars in use. With the new vestibules, the fenders now protruding over the dash rail will be useless, as they cannot be properly operated; 1200 new fenders have therefore been ordered, and the old fenders will be used on the cars which remain without vestibules. The vestibuling of the cars is in accordance with the Thonet law, which states that one-third of the cars must be vestibuled the first winter, an additional third the second winter, and the balance the third winter.

Thirty years ago there were not over half a dozen engineering colleges in the country, and they turned out on an average probably not as many as twenty graduates in a year. According to Professor William Kent, of Syracuse University, there was then no great demand for them, but within the next ten years, when several hundred of such graduates had shown what results they could achieve in practice, often before they were thirty-five years of age, the public began to understand what an engineering graduate was, and soon there was a ready and ever growing market for his services. The demand for such graduates has been met by the organization of a hundred or more engineering colleges throughout the country, many of them as departments of universities. There are now probably not less than 15,000 students in these colleges, and the number is increasing rapidly.

Six parts of whitelead, six of sulphur, and one of borax, thoroughly mixed and wetted with strong sulphuric acid, make a very strong cement for iron, says the "Engineering and Mining Journal."



Electrical and Mechanical Progress

A Gasolene Soldering Iron and Blow Torch

THE combination automatic gasolene soldering iron and blow torch shown in the accompanying illustration is made by the Emmelmann Brothers Manufacturing Company, of Indianapolis, Ind. The illustration is one-third the actual size of the tool.

In operating this device, the cap at *A* is removed and the magazine filled with gasolene within ½-inch of being full; then the cap is screwed on firmly. The alcohol lamp which accompanies each tool is lighted, and the iron is heated at *B* for at least three minutes in a slanting position with the head down, keeping the valve *C* closed to generate a hot gas pressure. After heating the iron *B* the stated time, the valve *C* is gently opened and lighted by passing the tool over the flame at *F*. The tool should continue to be heated at *B* for three minutes more. The operator can regulate the blast to adapt it to the work by means of the valve *C*.

If the work is being done outside in a heavy wind, or the tool is used as a blow torch, the shutter at *B* should be closed. By removing the copper point shown at *E*, the tool can be used as a blow torch. In case the tool does not work readily, the steel head shown at *F* can be unscrewed and the small hole in the center of the plug cleaned with a fine wire; the hole, however, should not be enlarged.

When properly started, it is claimed that every particle of gasolene is consumed, and that there is no danger of explosion. The cost of keeping the tool in constant operation is said to be only about 5 cents a day. It is intended for use by electricians, linemen, tinners, plumbers, and painters. The tool is furnished with two drop-forge coppers,—one for regular work and one for heavy work.

A COMBINATION GASOLENE SOLDERING IRON AND BLOW TORCH MADE BY THE EMMELMANN BROTHERS MANUFACTURING COMPANY, INDIANAPOLIS, IND.

Reaching a Chimney Top by Parachute

AN account is published in the "American Miller" of the manner in which a correspondent elevated to the top of a steel stack, and fastened there, a block and fall for use in painting. The stack was not provided with the usual means for doing this, the top being bare and having no pulley or cord attached to it. The account says:

"I procured a double and single steel block, 320 feet of ½-inch rope, 200 feet of chalk line, 200 feet of common fish line, ½ yard of cheesecloth, a stick 1 inch square about 8 feet long, together with 90 feet of ⅜-inch rope, which I happened to have. A pail and some wrapping twine completed my outfit.

"Tying one end of the fish line to the handle of the pail, I ran the line loosely into the pail so that it might be rapidly withdrawn without resistance. I tied the other end to four pieces of line about 2 feet long which had been tied to the corners of the cheesecloth, thus making a parachute. The pail was then placed in the bottom of the stack, and by means of a stick an assistant lifted the parachute above the opening through which the boilers are connected.

"After a few unsuccessful trials the gases caught the parachute and took it up through and out of the top of the stack. It was a very windy day and the fires were banked. The parachute was secured, and by means of the chalk line the ½-inch rope was drawn up through the inside and down the outside of the stack. The hook on the double block was replaced by one made of ⅝-inch steel and of suitable size to hook over the band at the top of the stack. The blocks were then threaded up with the other end of the ½-inch rope and pulled about 12 feet apart.

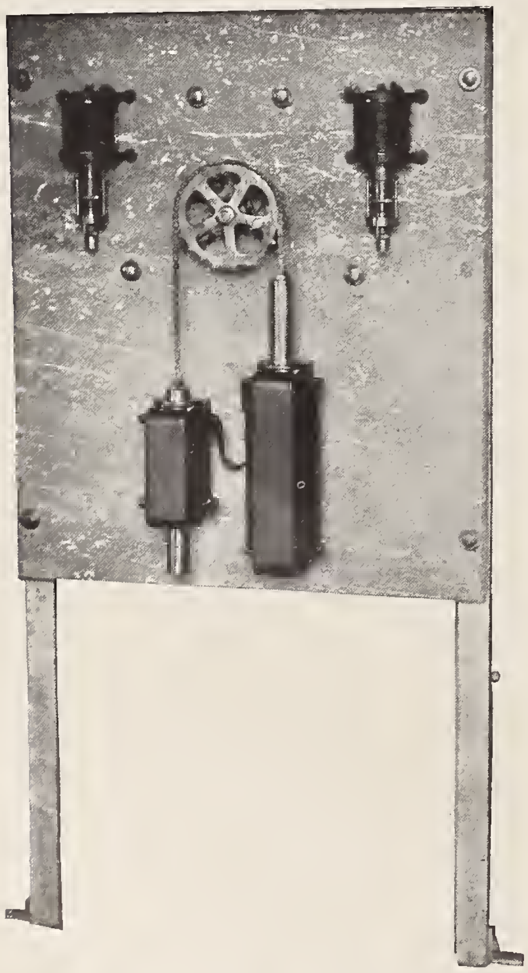
"The tackle was then bound to the stick and to the ½ inch rope, which

was now hanging on the outside of the stack. The old ⅜-inch rope was tied into the hook of the single block and the tackle hoisted by pulling the ½-inch rope down and out through the manhole in the stack. Getting the hook over the stack band required some patience, but was finally accomplished. When secured, a few hard pulls broke the wrapping twine by which the tackle was bound, and the ½-inch rope fell down the inside of the stack, and the stick on the outside. We then pulled down the single block by means of the fall, and attached the bos'n's chair that is ordinarily used for stack-painting."

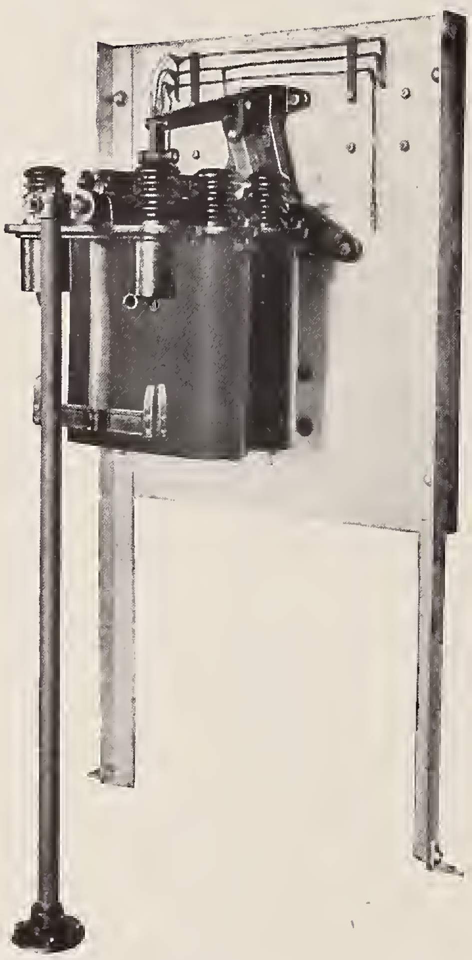
Electrically Controlled Oil Switches

THE tendency to design all central station apparatus so that it can be controlled from a central controlling board has led to a demand for a simple and inexpensive system of electrical control for high-tension oil switches or circuit breakers.

In the two accompanying illustrations are shown front and rear views of a 15,000-volt electrically controlled oil circuit breaker made by the Hartman Circuit Breaker Company, of Mansfield, Ohio. The panel containing the oil switch, operating solenoids and overload relays may be installed at any convenient point in the station and operated from the main switchboard by means of a small double-throw switch.



FRONT VIEW OF THE 15,000-VOLT AUTOMATIC OIL CIRCUIT BREAKER WITH CONTROLLING SOLENOIDS AND TIME LIMIT OVERLOAD RELAY, MADE BY THE HARTMAN CIRCUIT BREAKER COMPANY, MANSFIELD, OHIO



REAR VIEW OF THE HARTMAN OIL CIRCUIT BREAKER, WITH ONE OF THE OIL TANKS REMOVED

A rotary movement is used in opening and closing the switch, and the usual operating handle is replaced by a steel sprocket wheel. The link belt which engages the sprocket wheel is attached at one end to the movable core of the closing solenoid, and at the other end to the core of the opening solenoid. The downward movement of the core of the larger solenoid effects the closing of the switch, and the same movement of the core of the smaller solenoid effects the opening of the switch. The small double-throw switch for operating the indicating lamps on the main switchboard is located on the operating shaft back of the sprocket wheel.

The operating current is derived from the exciters, a storage battery, or any convenient source of direct-current supply. The solenoids can be wound for any standard voltage. When an automatic switch is required, the overload relays are placed on the same panel, and the operation of the plunger of either relay will close the direct-current circuit and effect the opening of the circuit breaker.

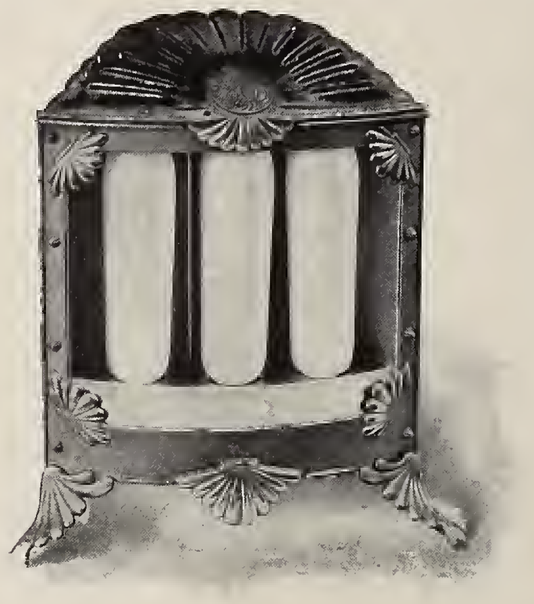
A combined overload and inverse time limit relay may be seen in the front view shown. The time relay operates on the vacuum principle, the admission of a smaller or greater quantity of air into the brass tube containing the plunger having the effect of retarding or accelerating the movement of the latter. On an ordinary overload the automatic opening of the circuit breaker may be delayed for any desired period up to 10 seconds. The heavier the overload, however, the quicker is said to be the action of the plunger, and an excessive overload or short circuit is claimed to cause the plunger to act almost instantly.

The switch in the rear view shown is of three-pole standard type, and is made for potentials up to 22,000 volts. The live parts are enclosed in a cell made of specially treated indurated fibre. The contacts are of the laminated double-break type, and the oil tanks are moulded in such a way as to isolate each breaking point.

A Luminous Electric Radiator

THE luminous electric radiator illustrated on this page is made by the General Electric Company, of Schenectady, N. Y. It consumes 750 watts, and consists of an ornamental cast-iron frame with oxidized copper finish, fitted with a polished copper reflector at the back and with three large cylindrical incandescent heating lamps. These "lamps" differ from the ordinary incandescent lamps for lighting, being specially designed to transform the electrical energy into heat, which the reflector throws out, accompanied by a cheerful glow.

The source of heat is a small filament which becomes incandescent immediately upon the turning on of the current. This radiator is claimed to consume a moderate amount of power for the service it gives, and to be especially adapted for giving tempo-



A LUMINOUS ELECTRIC RADIATOR MADE BY THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

ONE OF THE GENERAL ELECTRIC LUMINOUS RADIATORS INSTALLED IN A FIREPLACE

rary heat in chilly days when it would not pay to start a fire for warming one or two rooms. Another use of the electric radiator is in the summer cottage where no regular means of heating is installed, or in the sick room where it is valued for its hygienic operation and perfect control.

With each luminous radiator is supplied 8 feet of special flexible cord, fitted with a detachable porcelain receptacle which engages with two small contact pins on the right-hand side of the radiator near the bottom. To install the radiator it is necessary to provide a suitable switch and attaching plug with fuse. A competent wireman should be consulted, in order to make sure that the wiring of the outlet, which is to supply the radiator, is of sufficient capacity.

The "American" Under-Feed Stoker as a Smoke Preventer

REFERRING to the article entitled "Mechanical Stokers as Smoke Preventers for Power Houses," by Prof. Charles H. Benjamin, in the October number of The Electrical Age, J. S. Van Cleve, general manager of the American Stoker Company, of Erie, Pa., writes:—

"It is very unfortunate for us that Professor Benjamin should have thought it necessary to go on record so emphatically in favour of the Jones stoker as he did on page 182. It seems somewhat presumptuous to differ with so able an authority as Professor Benjamin, and yet our experience has, to my mind, proved the error of his position. To quote from his article,—

"'A criticism frequently made in regard to mechanical stokers is that they will not respond quickly to sudden changes in the load, that it is difficult to keep a uniform steam pressure under such circumstances, and that for this reason they are not economical. * * * Minor fluctuations can be taken care of by the fireman unless they become too numerous or too violent. In the latter case the under-feed stoker with a plunger feed comes the nearest to satisfying the demands.'

"The above, of course, can refer only to the Jones under-feed stoker, as there are only two under-feed stokers worthy of mention—the Jones and our own—and the Jones is operated by plunger feed and ours by screw conveyor. To show the error of Professor Benjamin's statement, I can cite to you a concrete instance.

"About a year ago, in the Cincinnati Gas & Electric Company, where we have 44 stokers in operation, a sudden thunderstorm in the middle of the afternoon called for an increase of current from 18,000 amperes to 36,000 amperes in ten minutes. Three men were put on the staging throwing in the switches, and our stokers responded so promptly that the plant did not lose steam 10 pounds. Certainly neither the Jones or any other stoker could have done better. I am not prepared to say that the Jones would not have done as well, because I don't know, but I do know that where the Jones stoker is called upon to take care of sudden overloads like this, a smokeless stack is an impossibility. It stands to reason that there is more danger of smoke where the coal is thrown in spasmodically in jerks than where it is gradually thrown in with a uniform feed."

A Laboratory Motor-Lathe

THE laboratory motor-lathe shown in the accompanying illustration is made by the Emerson Electric Manufacturing Company, of St. Louis, Mo. It was designed especially for dentists' use in polishing and grinding. With it is furnished a set of eight chucks, a bristle polishing wheel, and a grinding wheel.

The motor measures $6\frac{1}{2}$ inches in length by 6 inches in diameter, and is guaranteed to develop 1-10 actual brake horse-power. On 60-cycle alternating current this outfit operates at approximately 3400 revolutions per minute. There are no brushes or commutator to require attention, and the motor may be connected by a plug in any lamp socket and easily moved from place to place.

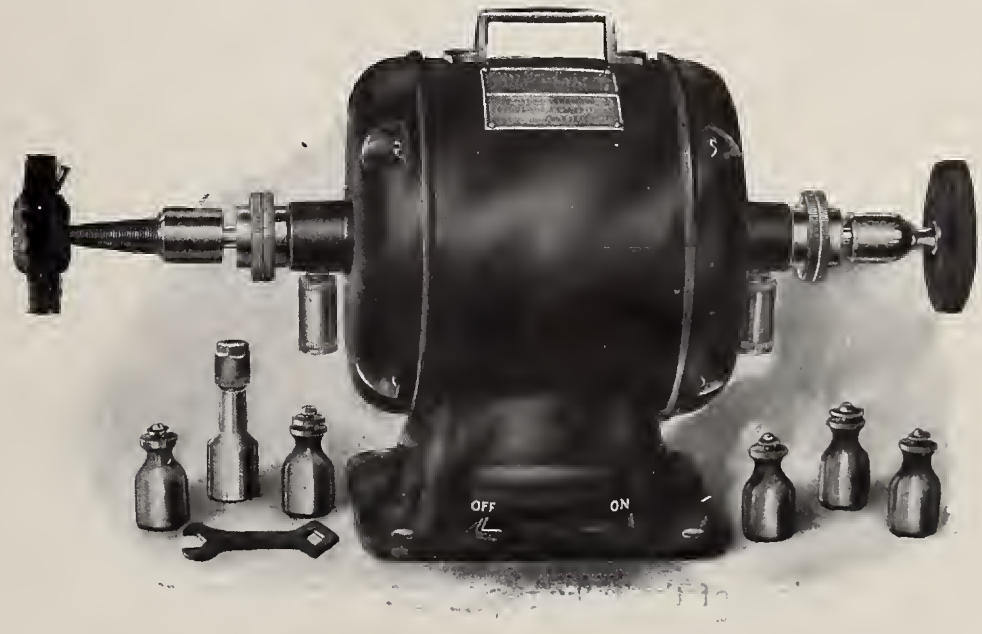
An automatic starting device brings the armature up to full speed in a few seconds. For convenience in stopping and starting, a switch lever is located in the base at the front where it is most accessible. Binding posts are provided inside the base, for attaching lamp cord, and an insulating bushing is located in the back of the base through which to bring out the cord.

In common with all induction motors, these lathes operate at one speed only, which it is impracticable to regulate. A handle is provided at the top of the motor, and the base is equipped with rubbers to prevent injury to polished surfaces. When desired, these rubbers may be removed and the motor firmly screwed to the bench or stand.

A Cheap Electric Glue Heater

ACCORDING to "Wood Craft," L. A. Worley, of Logansport, Ind., has used a home-made inexpensive electrically heated glue pot for some time with excellent results. Its arrangement is shown in the annexed cut.

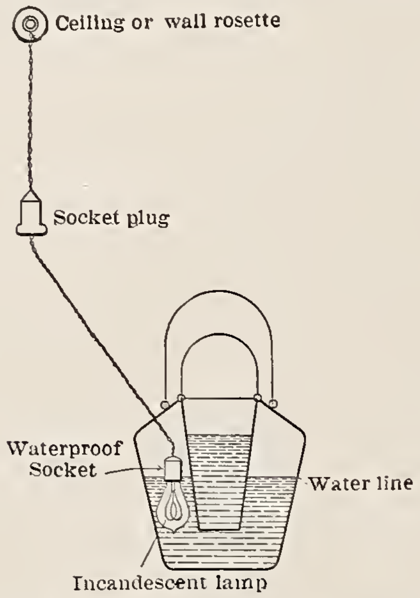
The heat of the incandescent lamp brings the water rapidly to the right



A LABORATORY MOTOR-LATHE MADE BY THE EMERSON ELECTRIC MANUFACTURING COMPANY, ST. LOUIS, MO.

temperature and keeps it there. Mr. Worley uses a thirty-two candle-power lamp if the glue is to be heated speedily. He finds a six or eight candle-power will keep the kettle warm enough for constant usefulness. The lamp will boil the water in a glue kettle of the ordinary size in from two to four minutes. This can be shown by a convenient trial of the incandescent lamp suspended in about the same quantity of water as is contained in the average glue kettle.

Mr. Worley has found that much depends upon the tightness of the



ARRANGEMENT FOR HEATING A GLUE POT BY MEANS OF AN INCANDESCENT LAMP

joints between glue pot and kettle, etc. The closer the water is confined with the immersed lamp, the better the results. It is impossible to keep the hand on the lighted lamp in the water and when the lamp is closely confined much of the heat is retained that would otherwise be dissipated without any useful result whatever.

Mr. Worley is a contractor and builder in Logansport and has found this device very handy in his business.

Steel Wheels for High-Speed Electric Cars

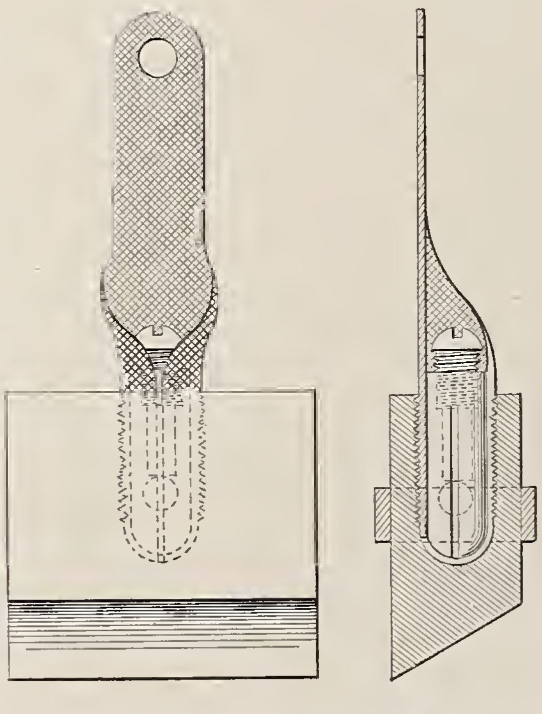
THE use of steel wheels on high-speed electric railways, says the "Railway and Engineering Review," is increasing daily and gives indication of soon becoming universal. The progress in this direction has been merely a repetition of steam railway experience. In each case the beginnings have been with light-weight cars, for which service the chilled cast-iron wheel seemed adequate. Later, the speed increased, and with it the weight of the rolling stock. The result in electric service, as in steam, has been the failure of the cast-iron wheel and the adoption of steel as an improvement. Authorities seem now to be united in saying that steel wheels and steel-tired wheels, in any of the various forms, are a decided improvement over cast-iron wheels. It seems to be only a question of time until they will be recognized as the only proper usage on heavy cars for electric service as they long have been for steam service. It is not easy to see why electric railway mechanics have not universally profited by the previous experience of steam railways and anticipated the results that have been so laboriously obtained by them. So far this has been done only in part, and many electric systems are painfully treading the path that the railways traced long years before.

A New Contact for Carbon Brushes

A NEW contact for carbon brushes on dynamo-electric machinery has been invented and patented by J. H. Hallberg, of New York, who has given the National Carbon Company, Cleveland, Ohio, the exclusive license to manufacture it.

As shown in the annexed illustration it consists of a brush or collector having a cavity, a terminal having one end turned to conform to the shape of the cavity, and means for forcing these parts into intimate contact.

The advantage claimed for this new form of contact over other types of carbon brush collectors is that the fittings can be used repeatedly as new brushes are substituted for the worn ones, thus limiting the loss each time to the unused portion of the carbon brush and so reducing the



A NEW CONTACT FOR CARBON BRUSHES MADE BY THE NATIONAL CARBON COMPANY, CLEVELAND, OHIO

cost of renewals. It is also claimed that the contact wire will not work loose from the brush on account of excessive temperature changes.

Electricity in Sub-Marine Mining

THE almost indiscriminate use of mines in naval warfare, as practiced by the two belligerents in the Far East, has gone far to illustrate the practicability of modern methods of exploding them, and not the least significant fact brought to light, states "The Electrical Review," of London, is the unsuitability of electricity where it can be avoided.

The chief reason for this is the liability to deterioration in the Leclanché cell, which even on open circuit is apt to run down in consequence of leakage. Those who are accustomed to associate the Leclanché cell with the common house-system of bell circuits will hardly realize this liability to deterioration, but it must be borne in mind that the conditions under which the cell has to carry out its functions are very different.

In the ordinary house-circuit the wires are under cover and protected from dampness, and even where they are exposed to the weather, they have the advantage of evaporation for drying purposes. Thus it is that the insulation is so perfect that leakage is practically a negligible quantity. It is very different in submarine mining.

To begin with, the type of cell used in the navy is of very low resistance; in the ordinary "boat's battery" type which we have in mind, it is about two-tenths of an ohm, and therefore capable of giving a comparatively large current. The cells are either made up into large batteries of about 80 cells, for use in controlling the mines from a shore station, or are placed in the mine itself, a pair to a mine; in the latter case the mines are self-contained, and are known as "electro-mechanical" mines. The circuit has only one break, known as the circuit closer, and is otherwise completed through the detonators.

The circuit closer is a form of mercury contact which acts when the mine is bumped. Now, when a mine has been laid out for some time, the interior of it, even supposing there be no leakage of water through the joints, gets very damp, the iron case sweats a good deal; there is a certain amount of leakage, therefore, across the terminals of the battery, and this is assisted by the slight creeping of sal-ammoniac, which, in

spite of precautions almost invariably takes place to some extent. This creeping may, perhaps, be in a large measure caused by the tidal and wave motion to which the mine is subjected, causing the liquid to wash about and leave deposits above its normal level.

The Japanese have, it seems, rather successfully used dry cells in spite of their liability to deterioration, and here we may, perhaps, digress for a space, to give our experience of the deterioration of dry cells stored under naval conditions. These cells, when their internal resistance has gone above a certain standard, are broken up as old zinc, and it is almost invariably found that the cause may be traced to local action in the zinc eating it away and covering it with scale.

From whatever cause it may be, however, experience has shown that batteries used inside a mine deteriorate quickly, and are, therefore, unreliable after a certain length of time.

Batteries used outside a mine and on a circuit to be closed by a mechanical device inside it, run down through leaks in the submarine cable. The circuit here is invariably "earthed" through the steel armouring and so back through the sea water; consequently the minutest leak soon develops.

It would appear, therefore, that electricity for automatic mines is doomed, and that its place will be taken by some purely mechanical device which will become released when the mine is struck, like the "horned" mines of the Russians; it is a pity that it should be so, for such mines, breaking adrift as many have done in the China Sea, become a lasting danger to shipping until they have been destroyed.

While speaking of mines and the application of electricity to them, it is curious to note that there have been proposals to fit them with zinc plugs, which, by galvanic action, eventually become eaten away and drown the explosive, sinking the mine, and thus putting it out of action.

The Third Rail for the New York Central Railroad

A MODIFICATION of the ordinary type of contact rail is to be adopted by the New York Central Railroad for its New York City electrical zone. In the new rail, contact is made from beneath so that the rail can more thoroughly be protected and made safer than in the case of the ordinary type of third rail construction. As there are no projecting live parts and no opening between the third rail and its cover, it is very improbable that any person or animal will accidentally come in contact with it.

Among other advantages claimed for it are:—Less strain on the insulators, as the pressure from the shoe acts against instead of with gravity; the board protection, having a continuous support, is less apt to crack and warp; the rail is better protected from the weather, and hence less liable to corrode; the contact surface is more thoroughly protected from sleet and snow; the construction is self-cleaning, and as there is a much greater space between the lower portion of the third rail and the tie, there will be less danger of an accumulation of snow, ice and rubbish, and consequently less leakage of current.

The third rail is supported by iron brackets spaced 11 feet apart; in each of the brackets are two insulation blocks which hold the rail in position. The rail is not mounted rigidly in the insulating block, but is given a little space for expansion and contraction, except at certain central points, where it is anchored.

Between the iron supporting brackets, the upper part of the third rail is protected by a wooden sheathing made in three parts and nailed together. This sheathing is mortised at the joints where the third rails are bonded, and at the feeder taps. The under surface of the third rail is 2¾ inches above the top of the service rail.

The Jones Mechanical Stoker

IN addition to the several mechanical stokers illustrated in connection with the article on "Mechanical Stokers vs. Smoke Preventers for Power Houses" in the October number of this paper, it may not be uninteresting at this time to call attention to the Jones stoker as well, —one of the under-feed type,—made by the Under-Feed Stoker Company of America, with headquarters at Chicago.

Fig. 3 of the several accompanying illustrations shows how the coal passes from the hopper on the outside of the furnace to the combustion chamber. The retort or fuel magazine, Fig. 4, is the portion of the stoker placed inside the furnace. Around the upper edge of the retort, tuyere blocks are mounted through which air is supplied. The auxiliary ram or plunger, which moves in connection with the main ram to secure an equal distribution of fuel after introduction into the furnace, is also plainly shown in Fig. 4.

The tuyeres are hollow iron blocks, and are the only parts of the stoker coming in contact with the fire. Their relative position in the completed setting of a return-tube boiler is shown in Fig. 5. Extending from

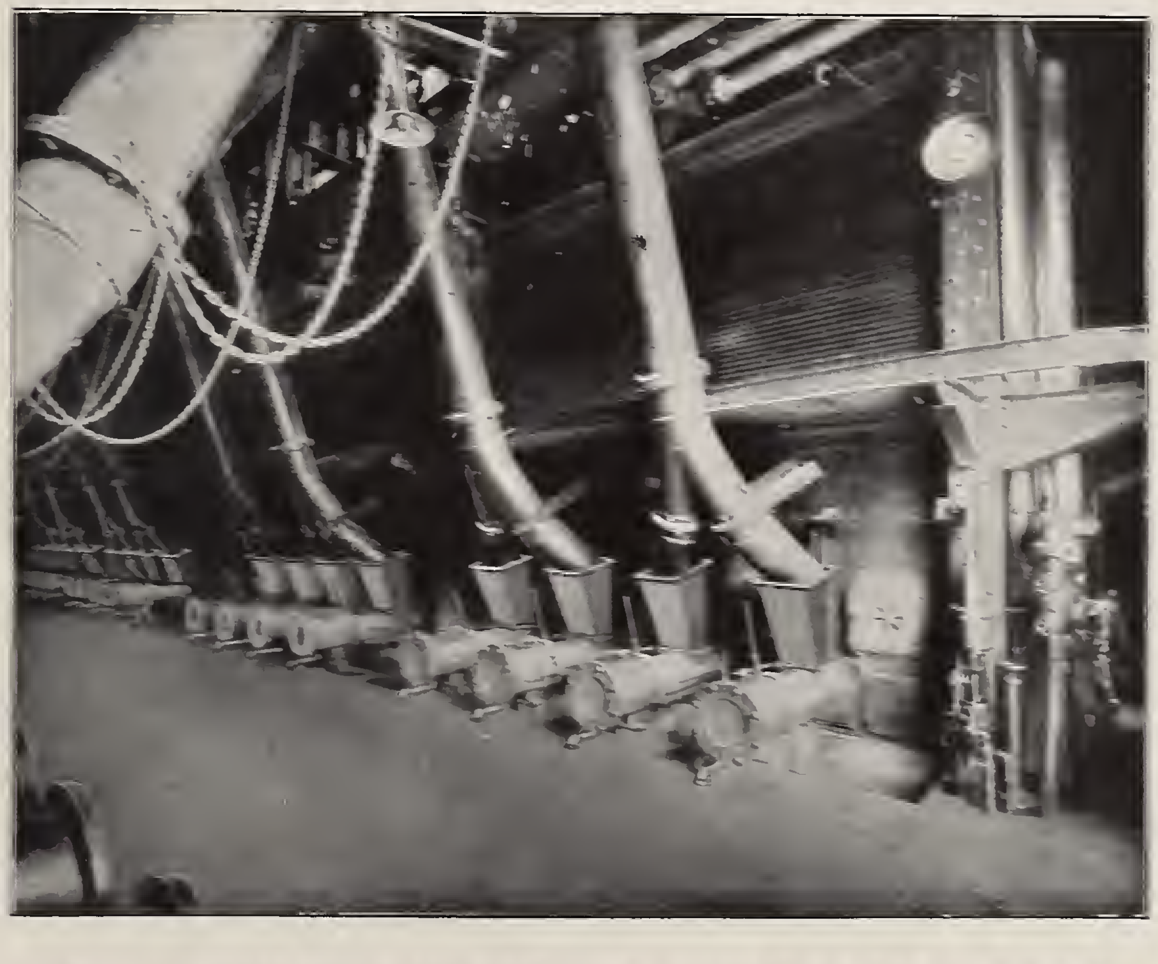


FIG. 1.—THE BOILER ROOM IN THE ONEIDA STREET STATION OF THE MILWAUKEE ELECTRIC RAILWAY & LIGHT COMPANY, EQUIPPED WITH JONES MECHANICAL STOKERS MADE BY THE UNDER-FEED STOKER COMPANY OF AMERICA, CHICAGO, ILL.

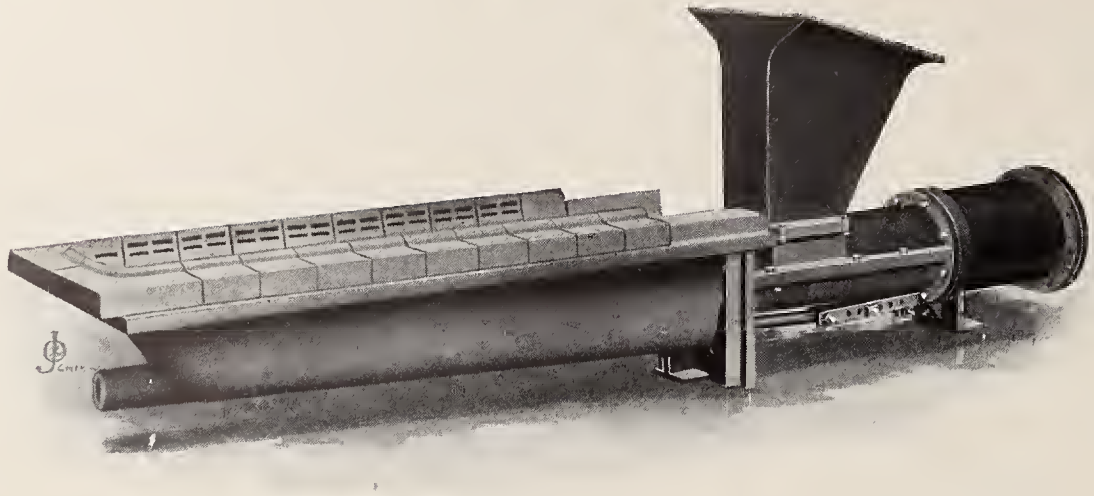


FIG. 2.—THE JONES STOKER COMPLETE AND READY FOR INSTALLATION

FIG. 3.—A SECTIONAL VIEW OF THE STOKER, SHOWING HOW THE COAL PASSES FROM THE HOPPER TO THE COMBUSTION CHAMBER

either edge of the retort to the side walls are the dead plates. The method of air entrance into the air chamber may be readily seen in Fig. 5. The ash pit becomes an air-tight chamber into which the air combustion is introduced under pressure, escaping through the tuyere blocks into the furnace.

The stoker complete and ready for installation is shown in Fig. 2.

In connection with this stoker a blower is used, which may be driven either by a steam or an electric motor. In the former case, the speed of the engine driving the fan is controlled by a regulating valve; and, driven from a belt connected to the blower, is a disc valve (or valves, according to the number of stokers) placed upon a stand close to the fan, each valve controlling admission of steam to a stoker cylinder. When the steam pressure rises to a certain point, the regulating valve on the steam line to the blower engine throttles the steam supply; the speed of the blower and disc valve is reduced, thus decreasing the interval of movements of the stoker ram. The operation is reversed automatically should the steam pressure fall, while the reciprocal relation is maintained at all times. Thus the output of air and the quantity of fuel are in proportion and governed by the requirements for steam. If the blower is driven by an electric motor, its speed is automatically controlled by steam pressure by means of a special electrical regulating device.

Electric Operation of Coal Breakers

A GOOD deal of interest has been exhibited among colliery engineers, especially those engaged in the preparation of anthracite, by two large breakers recently erected in the Pennsylvania field, in which several important innovations in the practice of coal preparation have been planned. One of these plants is the Truesdale, of the Lackawanna Company, which, says "The Engineering and Mining Journal," is particularly noteworthy, not only as being the breaker of largest capacity yet erected in the Pennsylvania anthracite region, but also for the fact that it is to be operated exclusively by electric power, individual motors being employed for the various machines.

In the case of the Truesdale breaker, this is no experiment, the Lackawanna Company having been trying electric motors in the same way at other collieries for several years back, especially at the Auchincloss plant. In the Truesdale plant, the only important modification is the employment of alternating-current induction motors, instead of the direct-current motors which have previously been used.

There is probably no question as to the superiority of the induction motors for such application, especially in view of the flying dust, which is inevitably experienced in a coal breaker. As to the broad advantage of operating coal breakers by electric power, there is naturally a difference of opinion, and more experience in the matter must be gained before engineers will come to general harmony of opinion. The idea of driving a machine by an independent motor is at first sight quite attractive. Many mills and machine shops have been provided with power in that manner. It has appeared, however, as a result

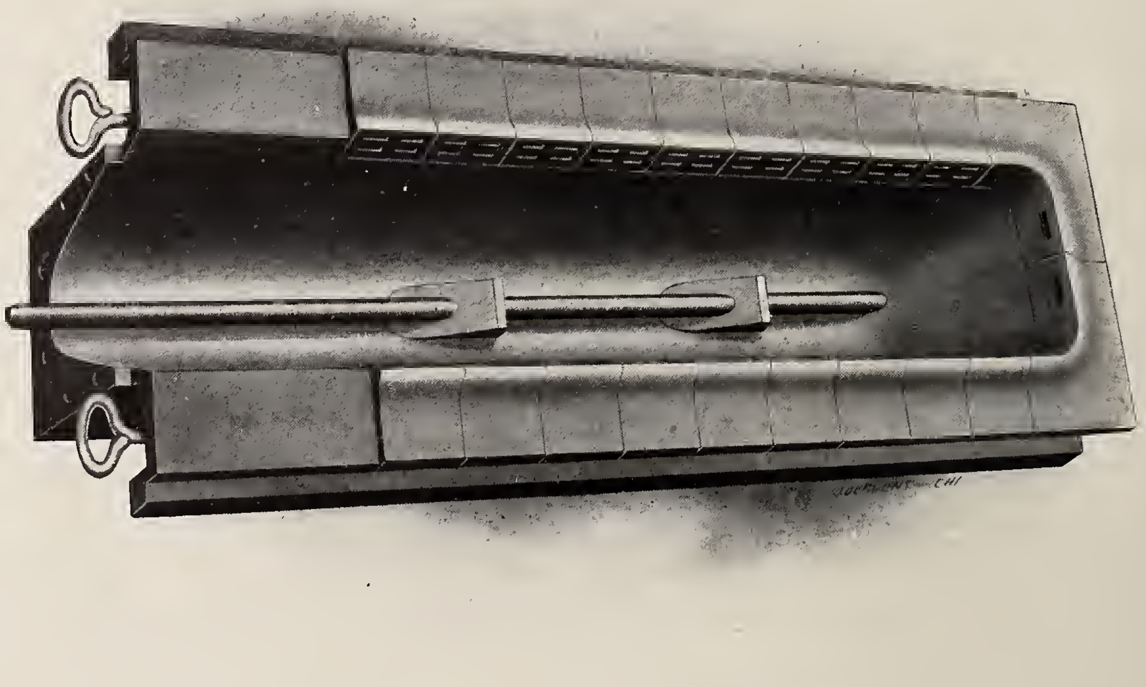


FIG. 4.—THE RETORT OR FUEL MAGAZINE, TOGETHER WITH THE AUXILIARY RAM FOR SECURING AN EQUAL DISTRIBUTION OF FUEL

of experience, that there has not been in all cases a saving in power, or some other advantage; but, on the contrary, the reverse.

It is now generally recognized by engineers that there is such a thing as over-electrification, and the selection of the power equipment of a plant must be made with the same kind of discrimination that is necessary in other matters of mill construction.

FIG. 5.—A RETURN-TUBE BOILER EQUIPPED WITH A JONES STOKER, SHOWING THE POSITION OF THE TUYERES AND THE METHOD OF AIR ENTRANCE INTO THE AIR CHAMBER

However, it may be considered that independent motor drives may be more advantageous, for particular reasons, in a coal breaker than in certain other forms of mills. The interior of the breaker building is rather a confusion of trusses, timbers, posts, and chutes, among which are arranged the screens, crushing rolls, slate pickers, conveyors, etc. The designer of such a plant becomes well aware of the difficulties when he comes to the point of preparing the shafting, belting, and pulley plans. The design is certainly very much simplified, if a difficult situation can be circumvented by the use of a small independent motor. Moreover, there are certain advantages in the simplification of the power-transmitting mechanism of such a plant as a coal breaker, directly connected with the management of the plant, which may outweigh a disadvantage in first cost and operating expense.

Electrical power installations in coal-breaker practice will doubtless afford the best economical results when it is possible to supply several mines, or groups of mines, from one large central power station. The Lackawanna Company already has two such plants, viz., the Hampton, near Scranton, which operates the Keyser Valley mines, and a new plant at the lower end of the Wyoming Valley. The Baltimore Tunnel breaker of the Delaware & Hudson Company, is another example of electrically driven breakers of modern construction.

The Future of the Gas Engine

FROM a thermo-dynamic point of view, the gas engine is a machine which ought to be exceedingly good; but the difficulties in building, especially very large engines, and saving by having the heat produced where used, reduce the efficiency of the engine enormously.

In spite of that, according to James Swinburne, in a presidential address not long ago, before the Institution of Electrical Engineers, the large gas engine seems likely to oust the steam engine for large powers during the next few years. The best way to get a high efficiency out of a gas engine would probably be to make it compound, exhausting at a temperature suitable for raising steam, which, after doing work in a steam engine, would exhaust at a temperature suitable for raising sulphurous acid vapour. But the chances are that Dowson, Mond, or other producer gas will be available at such low prices that the extra steam and dioxide engines would not pay for attendance, interest and depreciation. With very cheap gas the first thing is to make big engines, the next to make them so that they never break down, and the last thing, to make them efficient. The gas engine may be, comparatively speaking, in the state Watt left the steam engine; but it will doubtless make very rapid advances.

Two steam turbine sets of 10,000-H. P. each are being installed at a Rhenish-Westphalian power station.

Trade News

The J. G. Brill Company, of Philadelphia, has received an order from the Spokane & Inland Railway Company, of Spokane, Wash., for eighteen interurban passenger coaches and two large interurban express cars. Six of the passenger cars are to be 53 feet over the bodies and mounted on motor trucks, and twelve will be 45 feet over the bodies and will be operated as trailers. These cars are to be similar in design to those recently furnished to the Coeur d'Alene & Spokane Railway by the Brill Company. The cars will have arched top twin windows, will be vestibuled at both ends, and in appointment and equipment will be thoroughly modern in every respect. The system of the Spokane and Inland Railway Company, which is nearing completion, is 146 miles long, and extends from Spokane in a southerly direction to Pullman, and thence easterly to Moscow in Idaho, passing through a number of the most important towns in western Washington. The road will be operated in connection with the Spokane Terminal Railway and the Spokane Traction Company, all of which are third-rail system high-speed lines.

It is announced that the Pratt & Whitney Company, of Hartford, Conn., have purchased a plant in Dundas, Ont., for the manufacture of their full line of small tools—taps, reamers, milling cutters, punches, dies, etc., etc.

The building is a modern structure and the power plant is already in place. The machinery equipment is being gotten ready at Hartford, and will be sent there and operations begun immediately. The plant will also include a department for manufacturing a full line of twist drills, an elaborate equipment of special machinery having been gotten ready for the purpose. The location of the factory is near that of the John Bertram & Sons Company, which, as has been announced, was recently purchased by the Niles-Bement-Pond Company.

The Brill and allied companies report that they are building at present Brill groveless-post semi-convertible cars for twenty-six different companies, including four foreign orders, aggregating in all 767 cars.

The Boston office of the Fort Wayne Electric Works, of Fort Wayne, Ind., under the management of J. Allan Smith, has moved from its old home in 518 Exchange Building into more commodious quarters

at 110 State Street, rooms 601-604 Plymouth Building. This change was necessitated by the large increase in business transacted by this office and the desire to handle it advantageously.

An increasing demand for the gas engine is noticeable, due no doubt to greater appreciation of the excellent operating economy of this class of prime mover. The Westinghouse Machine Company, of East Pittsburg, Pa., have received within the last few weeks many orders for gas engines, ranging from 10 B. H. P. to 1000 B. H. P. No less than thirty-six gas engines are covered by these orders, aggregating 6647 B. H. P. One of the most recent and significant orders was received from the Rockland Electric Company, of Hillburn, N. Y., for two 500-H. P. double-acting horizontal tandem gas engines. This company has already in operation three 19-inch by 24-inch Westinghouse double-acting gas engines, direct-connected to generators, and this second order serves as a testimonial of their satisfaction with the use of gas engines as prime movers.

Another order worthy of special mention is one from the Union Traction Company of Kansas, Independence, Kan., for one 500-H. P. horizontal tandem gas engine, and one 1000-H. P. horizontal twin tandem gas engine, both for A. C. generator driving in parallel.

By the recent amalgamation of the water-tube boiler business of the Aultman & Taylor Machinery Company, of Mansfield, Ohio, and that of the Stirling Company, of Barberton, Ohio, a new company, to be known as the Stirling Consolidated Boiler Company of New York, has been formed to take over the combined enterprises.

It is announced from London that the "Long-Arm" System Company, of Cleveland, Ohio, has been awarded a gold medal for its Earl's Court exhibit of "Long-Arm" electrically operated power doors for ships. This was one of the few displays of American devices in the naval, shipping and fisheries exhibit. The exhibit of this system, by which bulkhead doors are closed from a central station in time of an emergency, has attracted the favourable attention of many European naval experts. Foreign admiralties are investigating it with a view to its adoption, following the example of the American Navy, which has installed the "Long-Arm" system on thirty-two of its ships. The development of automatic bulkhead doors has been effected wholly within the United States Navy. Francis T. Bowles, formerly chief constructor, first conceived the idea of an electrical apparatus for operating these doors. Another graduate of the Naval Academy, W. B. Cowles, who is the vice-president of the Long-Arm Company, perfected Admiral Bowles' idea into the practical system now in use.

G. M. Gest, subway contractor, of New York and Cincinnati, has been awarded a contract for the construction of a complete electrical subway system for the Dayton Lighting Company, Dayton, Ohio. This plant has recently been acquired by new interests, who are rebuilding and re-equipping the whole plant. The contract given to Mr. Gest is for subway installation for the whole city, covering 20 miles of streets and involving over 1,000,000 feet of conduit. The system is to be absolutely modern and up to date; the amount involved will be in the neighbourhood of $250,000.

Three orders of large size have recently been received by the Westinghouse Machine Company, of East Pittsburg, Pa., for their Roney mechanical stoker. One order from the Jones & Laughlin Steel Company, of Pittsburg, Pa., calls for sixteen 114-inch x 24-inch grate stokers; one from the Lehigh Valley Traction Company, of Philadelphia, Pa., calls for eight 130-inch x 20-inch grate stokers, and another from the Pressed Steel Car Company, of Pittsburg, Pa., covers six 100-inch x 20-inch grate stokers. These stokers are of the inclined rocking-grate type with removable fuel plates, and are provided with the necessary actuating mechanism for automatically controlling the motion of the grate-bars and the supply of fuel. They will be capable of burning low-grade bituminous coal efficiently and without smoke.

When the large Union Station at the Washington terminal of the Pennsylvania Railroad is completed, it will be one of the finest and best equipped railroad stations in the world, serving all incoming and outgoing trains of Washington. In conformity with the rest of the station the power plant will be equipped with the most up-to-date and best machinery obtainable, steam turbines being selected as prime movers partially on account of the limited amount of space devoted to that purpose. Four 500-KW. steam turbines have been ordered from the Westinghouse Machine Company, of East Pittsburg, Pa., adapted for driving alternating current 60-cycle generators running at 3600 revolutions per minute. Dry saturated steam will be used at 150 pounds pressure and 25-inch vacuum, and the turbines will be capable of developing 670 electrical horse-power each. The alternating-current generators will be of the turbo-rotating field type with two poles and a frequency of 7200 alternations per minute at a normal speed of 3600 revolutions per minute. They will deliver three-phase current at 2300 volts, and, being of the enclosed type, will operate practically without noise.

Baker & Company, Inc., refiners and manufacturers of platinum, gold and silver, Newark, N. J., and New York City, have been awarded a gold medal, for the excellency and variety of their exhibit at the recent "Lewis and Clark Centennial Exposition," at Portland, Ore. Being the first exhibit of its character on the Pacific Coast, and located in the Mines and Metallurgy Building, under Government supervision, it attracted the special attention of a large number of visiting miners and metallurgists, who, in recent years, have been devoting greater care to the recovery of the platinum known to exist in the alluvial deposits along the Pacific Coast. Baker & Company's exhibit was very comprehensive in its character, including numerous samples of crude platinum ore, the salts and solutions of the metal, and various forms of platinum ware, such as are used daily in the arts and industries.

The Rail Joint Company was recently organized by filing at Albany, N. Y., a certificate of incorporation with a capital stock of $1,500,000, of which $1,000,000 is common stock and $500,000 is preferred stock. The officers of the company are: President, Frederick T. Fearey; vice-presidents, Lawrence F. Braine and Percy Holbrook; Fernando C. Runyon, treasurer, and Benjamin Wolhaupter, secretary. The company will take over the business and properties of the Continuous Rail Joint Co. of America, the Weber Railway Joint Mfg. Co., and the Independent Railroad Supply Co.

The Hatch Accumulator Company, of Boston, Mass., announce their reorganization for the purpose of vigorously introducing their specialties to the trade.

To the Rockland Electric Company, of Hillburn, N. Y., belongs the credit of inaugurating an interurban electric supply system from

by-product producer gas fuel in connection with power and fuel gas supply to adjacent industrial works. The use of gas power arose from the extremely low fuel cost of gas power and from the advantages of fuel gas in furnace work. The present power equipment, totaling about 1075 B. H. P. generating capacity, not including an exciter unit, consists of three 19-inch x 24-inch Westinghouse double-acting gas engines, direct connected to 225-KW. Westinghouse two-phase generators and a 75-KW. Westinghouse vertical three-cylinder unit for operation during light loads upon the plant. Having found its present equipment inadequate to meet the increasing demands for electricity, the Rockland Electric Company has placed an order with the Westinghouse Machine Company, of East Pittsburg, Pa., for two additional 23-inch x 30-inch two-cylinder, double-acting, horizontal tandem gas engines. These engines will be of the 4-cycle type, imparting two impulses to the crank shaft at each revolution irrespective of the load.

Each will drive a 60-cycle alternating-current generator, and will operate on producer gas of approximately 125 effective B. T. U. per cubic foot. The normal rating of each engine will be 470 B. H. P., and each will be capable of developing 10 per cent. overload for a period of two hours. After the installation of the two engines now on order, the total capacity of the equipment will approximate 2100 B. H. P. The gas power plant of the Rockland Electric Company has been in continuous operation during regular working days for nearly a year, supplying current for lighting the surrounding towns, power for adjacent Ramapo Iron Works and fuel gas for a number of heating furnaces. The principal product of the gas plant—water gas —is exclusively used for this purpose on account of its high flame temperature, while power gas is a by-product. Both gases are generated by one system,—the Loomis-Pettibone—three complete generating sets being in use. It is frequently the case that the cost of electric current in small suburban communities is prohibitive to a large number of residents, resulting from the high cost of generating steam power; but in this case, owing to the ability of the gas engines to thus turn to useful account a practically waste product, the cost of current is greatly reduced and the cost of an otherwise expensive gas is decreased sufficiently for general manufacturing purposes.

During the past two months the Westinghouse Machine Company, of East Pittsburg, Pa., has booked many orders from foreign countries. Some of the important steam-engine orders are:—One 16-inch by 34-.nch by 16-inch marine type vertical cross-compound engine for the Kure Arsenal, Japan; four 16-inch and 34-inch by 16-inch marine type and two 8½-inch by 8-inch standard engines for the Tehuantepec Railway, of Mexico; one 11-inch and 19-inch by 11-inch compound engine for the Furukawa Western Bureau, Japan; one 13½-inch by 12-inch standard engine for the Hokkaido Tanko Railway Company of Japan; two 10-inch and 18-inch by 10-inch compound engines for the Kuiskiu Railway of Japan; one 14-inch and 24-inch by 14-inch compound engine for the Imperial Printing Office, of Japan; one 9-inch and 15-inch by 9-inch compound engine for Graham Brothers, Stockholm, Sweden; one 18-inch by 16-inch compound engine for the Rio de Janeiro Tramway Light & Power Company, of Brazil, and one 18-inch by 16-inch standard engine for the Santa Cecelia Sugar Company, of Cuba.

The Locke Insulator Manufacturing Company, of Victor, New York, manufacturers of the Locke patent high-potential insulators, have broken ground for an addition to their present works. This addition will be a modern eight-kiln pottery specially designed for their particular work, and will be constructed entirely of reinforced concrete. This plant will be 180 feet square and two stories high and will include the most modern methods of handling clay, coal, etc. There has been a very considerable extension in the Locke Company's plant during the past year, and this latest addition to the works will make them, it is understood, by far the largest in the world devoted to this exclusive product, and nearly equivalent to all other American productions combined.

A special meeting of the stockholders of the Westinghouse Machine Company has been called for December 23, to consider the advisability of increasing the capital stock from $5,000,000 to $10,000,000, in order to accommodate the great increase in steam turbine and gas engine business.

The recent incorporation of the Gröndal-Kjellin Company, Ltd., of London, represents the beginning of active operations looking to the introduction into Great Britain of the Gröndal system of iron ore concentration and briquetting and the Kjellin process for the production of steel by electricity. Arrangements have been made by which Naylor & Company, 45 Wall street, New York, will represent both processes in the United States.

Some Recent Westinghouse-Parsons Turbine Orders

THE Westinghouse Machine Company, of East Pittsburg, Pa., manufacturers of the Westinghouse-Parsons steam turbine, have within the last few weeks received numerous orders for their turbines, among them being one from the Lumberton Cotton Mills, Lumberton, N. C., for one 300-KW. turbine; from the Waltham Gas Light Company, Waltham, Mass., for four 500-KW. turbines; from the Gulfport & Mississippi Coast Traction Company, Gulfport, Miss., for two 500-KW. turbines; from the Suburban Electric Company, Scranton, Pa., for one 500-KW. turbine; from the Pennsylvania Light & Power Company, Pittsburg, Pa., for one 500-KW. turbine; from the Water, Light & Gas Company, Hutchinson, Kan., for one 500-KW. turbine; and from the Winston-Salem Power Company, Winston-Salem, N. C., for one 750-KW. turbine. The turbine ordered by the Lumberton Cotton Mills will be of the well-known multiple-expansion parallel-flow type, driving a 60-cycle direct-connected generator running at 3600 revolutions per minute. It will operate at 150 pounds steam pressure and 26-inch vacuum, and deliver three-phase current at 440 volts. The turbines for the Waltham Gas Light Company will be of the same type and frequency, operating at 3600 revolutions per minute with dry saturated steam at 175 pounds gauge pressure and 28-inch vacuum. The alternating-current generators will be of the rotating field turbo type, delivering three-phase current at 2300 volts. The Suburban Electric Company's turbine, with characteristics similar to the above, will operate with dry saturated steam at the throttle of 150 pounds gauge pressure and with atmospheric pressure in exhaust pipe, and will be capable of developing 750 B. H. P. The turbines for the Gulfport & Mississippi Coast Traction Company will operate under 150 pounds pressure, 28-inch vacuum and 100 degrees F. superheat, and will be direct connected to 60-cycle turbo-generators running at 3600 revolutions per minute.

General Electric Company Awards at the Portland Exposition

ANNOUNCEMENT is made that the Superior Jury at the Lewis and Clark Exposition has approved the following awards in the Electrical Department, relating to the exhibits of the General Electric Company, which is the largest manufacturer exhibiting in that department.

The highest award granted by the Jury is a gold medal. This company received a gold medal for the best exhibit in the Electrical Department, and also gold medals on each of the following features of this exhibit:

(1) Curtis steam turbine.
(2) Meters and instruments.
(3) Time-limit relays and oil switches.
(4) Switchboards, meter-controlling panels, circuit breakers and lightning arresters.
(5) Direct and alternating-current motors.
(6) Direct and alternating-current generators.
(7) Static transformers.
(8) Automatic voltage regulators.
(9) Magnetic arc lamp.
(10) Alternating and direct-current enclosed arc lamps.
(11) Mercury arc lamps.
(12) Magnetic starting device for mercury arc lamps.
(13) Mercury arc rectifier.
(14) Railway motors and controllers.
(15) Mining locomotives.
(16) Searchlight and method of control.
(17) Progress and development in the art.

For its new metalized carbon filament incandescent lamps, the company also received a gold medal.

The Exposition, in common with all the recent American expositions, is lighted by Edison incandescent lamps, furnished by the General Electric Company. A very unique feature was the extended use of Meridian lamps.

The Erie as a Commercial Railroad

THE importance of the Erie as a commercial railroad is emphasized in an interesting little pamphlet recently issued by Louis Jackson, the industrial commissioner of the road. According to this, vast deposits of coal (anthracite and bituminous), oil, natural gas (fuel is the paramount factor in manufacturing), clays (sewer pipe, fire, and other), cement material, gypsum, building stone, salt, and numerous other resources exist on the line.

The territory between New York and Chicago traversed by the Erie is one of the greatest and most varied manufacturing territories of the world. Manufactured products of almost every kind ranging from pig iron, iron and steel manufactures, chemicals, products of copper, brass, etc., to leather goods, woolens, silks, cut glass, electrical supplies, etc., are produced in it.

At the Eastern end of the line industries of all kinds are established. Midway between New York and Chicago is the commanding iron and steel territory of the Erie Railroad. About 27 million tons of iron ore is supplied annually by the Lake Superior district (the output increases every year); it comprises 75 per cent. of all the iron ore consumed in the United States; the bulk of this ore comes to Lake Erie ports. The Erie Railroad has great ore docks at Cleveland and Buffalo, equipped with the most modern facilities. About 300 million tons of coal are produced annually in the United States. Pennsylvania alone furnishes about one-half of this supply. The iron ore must come to the coal. The ore comes down the line, the coal and coke go up the line. Any station in this territory where the ore meets the coal is the proper place for the manufacture of iron and steel products. Around Chicago, the western terminus of the Erie, is another great iron, steel and general manufacturing section.

Electrical Show Exhibits

AMONG the exhibitors at the Electrical Show, to be held at Madison Square Garden, New York, from December 12 to 23, will be the Natural Food Company, of Niagara Falls. This company is preparing a complete exhibit of its electrical machinery for manufacturing food products without the touch of a human hand, from the time the wheat is received until it is turned out in marketable form. The methods of cooking food products by electricity will form a particularly interesting and practical feature of this exhibit, not only because of the rapidly increasing uses of electricity to the culinary arts, but also because of its decreasing costs.

The uses of the dry cell in medicine and in surgery will be demonstrated by the National Carbon Company, of Cleveland, Ohio, who are going to exhibit a full line of the Columbia dry cells. This cell has proven of value in electrical therapeutics, and the exhibit promises to be of particular interest and value to the medical profession.

The uses of the telautograph will be shown by the Gray Telautograph Company, of New York. This instrument, by which the writer at one end of a wire may transmit his handwriting on an electrical machine to a similar machine at a distance, has been gradually coming into favour. As a means of conveying instructions, the instrument is of real service in the commercial world, particularly in view of the fact that signatures so placed on checks may be accepted as legal by the banks. The exhibitors will place telautograph machines about the building, where visitors will be allowed to operate them and study their mechanism and uses.

The Gold Car Heating & Lighting Company, of New York, is preparing an exhibit to show the modern uses of electricity in car heating. The exhibitors will also demonstrate the practicability of electricity to the heating of buildings.

In the exhibit of the National Carbon Company, of Cleveland, Ohio, will be shown a new type of carbon brush, which is described as a carbon brush with an expansible pig-tail attachment. This attachment is claimed to reduce the electrical loss between the surface of the commutator and brush holder to a considerable extent. Among the other exhibits of this company will appear a complete line of preliminary electric batteries, both wet and dry types, in lines adapted to automobile and gas-engine ignition, electric bells, enunciators, telephones, railway signals, gun firing, and submarine signaling. The picturesque uses of the products of this company will be given special attention.

The New York Telephone Company is busy perfecting plans to extend the scope of its exhibit at the Show. Beside the huge bell sign, studded with purple incandescent lights, which will surmount the center space in the Garden, and the model switchboard exhibit, it is now understood that the telephone people will add as a further attraction a line of theater telephones. This feature will possess great novelty to the New York public, who have never had the opportunity of listening to a dozen different plays and operas over the telephone.

The Electro-Dynamic Company, of New York, are busy preparing their exhibit. One feature of this exhibit will be one of their Inter-Pole motors driving another as a generator, the current to be used in

the electric illumination of their booth. Practical demonstration is to be made of the fact that the Inter-Pole motor can be overloaded 100 per cent. without sparking and be instantly reversed, still without sparking. Another feature of the exhibit will consist in a display of the different sizes of frames, showing how small and light the Inter-Pole motor is in proportion to its power. The ball bearings which add so much to the efficiency of this type of motor will be another feature of the exhibit. The exhibit will also include demonstrations of the Maloney transformers to show very high efficiency and low iron and idle-load loss.

The Standard Vitrified Conduit Company, whose office is at 39 Cortlandt Street, New York, will also be among the exhibitors. This company furnished all the third-rail insulators for the Interborough Rapid Transit Company for use both on the elevated and on the subway, and also supplied material for the Brooklyn Rapid Transit Company and the Scioto Valley Traction Company in Ohio. In view of the extensive operations of this company in telephone, railway and electric light underground conduit construction in the East, a practical exploitation of its work will be of special value to those interested in this line.

The electric signs to be used by the Exposition Company of America at the electrical show will be supplied by the George L. Mason Company, of 51 Dey street, New York. From the roof of the Garden this company will suspend an electric sign about 40 feet long, the wording on which will be changed to indicate the special features of the show which will be exploited from day to day. Near the booth of the George L. Mason Company will be erected an electric sign board 15 by 30 feet on which will appear the names of a few companies who are unable to prepare an exhibit, but who take this opportunity of associating themselves with the show and of having their names appear in the photographs that will be made of the Garden. Within the booth will be an exhibit of the various kinds of electric signs, arranged to show their construction.

New Catalogues

The American Transformer Company, of Newark, N. J., are sending out two new publications,—one a bulletin illustrating and describing their self-cooling, oil-filled transformers, and the other a pamphlet treating of the American transformer, for thawing out frozen pipes.

A very attractive catalogue has been issued by the H. T. Paiste Company, of Philadelphia, Pa., covering their line of electric light supplies. It is profusely illustrated, and their most recent price list is sent out with it.

A mailing card sent out by the Buffalo Steam Pump Company, of Buffalo, N. Y., calls attention to their line of steam pumps.

Motor speed controllers are treated of in "Catalogue No. 19,055," issued by the Ward Leonard Electric Company, of Bronxville, N. Y.

The Electric Water Purifying & Filter Company, of New York, have issued a pamphlet containing a descriptive statement, analysis, and reports of their new electrolytic process of water purification. This process is said to be applicable to the treatment of supplies for municipalities, commercial and industrial establishments, hotels, apartments, and for all domestic uses.

A new catalogue on cranes, issued by the Wellman - Seaver - Morgan Company, of Cleveland, Ohio, illustrates and describes cranes of the ladle, overhead traveling, gantry, and locomotive types built by this company.

Among the latest publications issued by the General Electric Company, of Schenectady, N. Y., may be mentioned several illustrating and describing their mercury arc rectifiers, porcelain receptacles for moulding wiring, direct-current multiple enclosed arc lamps, and railway line material and rail bonds. In addition to these, there is one devoted to a test conducted on their 2000-KW Curtis steam turbine.

The Arnold Company, of Chicago, Ill., in "Bulletin No. 13," supply an illustrated description of the hydro-electric plant of the Spring River Power Company, Joplin, Mo., built by them.

The Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., have issued a booklet on rotary converters. This explains the characteristics and construction of Westinghouse rotary converters, and gives instructions for their erection, operation, and care. The subjects are well presented, and the publication forms withal a valuable reference book for the electrical engineer.

The Warren Electric Manufacturing Company, of Sandusky, Ohio, are sending out a number of interesting advertising cards bearing on one side illustrations and particulars of some of their products, and on the other side useful information for engineers, such as street lighting tables, allowable pressure for steam boilers and the like. They are useful little reminders of the business of the Warren Company.

The Westinghouse Machine Company, of Pittsburg, Pa., announce in a new folder that they have added a storage battery department to their business. While the folder is a small one and devoted chiefly to illustrations, it is the first on this subject to be issued by the Westinghouse Machine Company, and well serves its purpose as an announcement of this new and important branch of their business. In a separate publication this company illustrate and describe the Roney mechanical stoker made by them.

A number of new bulletins brought out by the Emerson Electric Manufacturing Company, of St. Louis, Mo., treat of their bipolar enclosed motors, electric forge blowers, electric volume blowers and laboratory lathes. They also have a new booklet on single-phase induction motors, and motors for use on direct-current circuits.

The Foos Gas Engine Company, of Springfield, Ohio, illustrate and describe their gas and gasoline engines in an attractive catalogue of 39 pages.

"Locks and Hardware" is the title of a new book recently brought out by the Yale & Towne Manufacturing Company, of New York. It is a handsome volume of over 200 pages, 6 by 9 inches, substantially bound in board covers, lettered in gold, and intended especially for dealers who handle only the active goods of the company.

The Dean Electric Company, of Elyria, Ohio, have issued a reprint article entitled "Concerning Harmonic Party Line Systems," written by W. W. Dean, vice-president and chief engineer of the company, for a telephone journal. In the closing part of the bulletin, the Dean harmonic party line system is illustrated and described.

The latest of a series of bulletins published at intervals by the storage battery department of the Dayton Manufacturing Company, of Dayton, Ohio, has just been brought out. It contains much information regarding isolated lighting plants, and describes

in detail the systems of wiring employed, and the construction of the cells used, by this company.

"Supplement No. 1" to "The Insulator Book" brought out by the Locke Insulator Manufacturing Company, of Victor, N. Y., has recently been issued. In this publication the matter contained in "The Insulator Book" is brought strictly up to date, and those possessing the one should make sure to obtain the other.

Electric storage batteries of the unit accumulator type for car lighting, are illustrated and described in a bulletin issued by the National Battery Company, of Buffalo, N. Y.

The National Electric Company, of Wilwaukee, Wis., have issued a new bulletin treating of the belt-driven, alternating-current generators built by them.

WALTER M. McFARLAND

Personal

The candidates for office in the American Society of Mechanical Engineers for the coming year, to be voted upon at the coming annual meeting, early in December, are:—For president, Fred W. Taylor; for vice-presidents, Walter M. McFarland, Edward N. Trump, and Robert C. McKinney; for treasurer, Wm. H. Wiley, and for managers, Walter Laidlaw, Frank G. Tallman, and Frederick M. Prescott.

Mr. Taylor's principal engineering work has been in connection with what may not inaptly be termed production engineering,—high - speed tool steel making, and the introduction of price-rate systems for the payment of shop operatives. It was his persistent attempt to get uniformity in cutting tools that led to the discovery of the Taylor-White process, which is the only method known of producing tools whose cutting efficiency varies less than 1 per cent. This whole investigation involved at least fifty thousand experiments and cost probably over one hundred thousand dollars. The solution of this problem will always be connected with his name, and the book on Taylor's laws to be published shortly by himself will soon be recognized the world over as one of the greatest pieces of scientific investigation of the nineteenth century. His discovery, in connection with Maunsel White, of the Taylor-White process of treating steel is a piece of scientific investigation almost as remarkable, and in its results quite as far reaching, for it is the basis of all the modern high-speed tool steels which have so much reduced the cost of cutting metals. Mr. Taylor was also the first man to study scientifically the ordinary labour problems, and to determine exactly how much work of various kinds a good man suited to it could do.

FRED W. TAYLOR, THE NEXT PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Mr. McFarland is a Navy man, a late chief engineer, but for some years past has been acting vice-president of the Westinghouse Electric & Manufacturing Company. Of him, Admiral Melville wrote some time ago: "While I cannot but congratulate my good friend, George Westinghouse,—whose name is a synonym for engineering genius and business enterprise,—on McFarland's entrance into his official corps, I cannot but regret the loss to the fleet of one of its brightest men, and to myself of a most talented and loyal assistant, who passed from the Navy to serve his country, doubtless some day as a 'Captain of Industry' in the ever-widening field of American manufactures."

President Wm. H. Blood, of the National Electric Light Association, has appointed Paul Spencer, of Philadelphia; John F. Gilchrist, of Chicago, and Joseph E. Montague,

of Niagara Falls, as a committee to co-operate with the advertising committee of the American Association of Incandescent Lamp Manufacturers in the matter of assisting central stations in the adoption of advertising methods that will result in increased business.

The lamp manufacturers' association made an offer to the National Electric Light Association, at its Denver meeting last June, of $10,000, to be expended for the above purpose, and the offer being accepted, this committee has been appointed to complete plans for the work. One of the most important discussions at the Denver meeting was that upon advertising and general methods of getting new business, and it was pretty well shown that this part of the central station management was about the most important, yet in the majority of cases the most neglected, or the most imperfectly carried out. The papers and the discussions on the subject created great interest and enthusiasm among the representatives of the smaller stations, and many of the suggestions made in the papers and discussions were at once acted upon when they returned to their homes, and in several cases most gratifying results have been reported. The work of the present committee will undoubtedly be one of the most helpful things done for the members of the association.

Warren F. Hubley, recently representative of the Sunbeam Incandescent Lamp Company, at Philadelphia, Pa., has resigned, in order to accept the position of Western representative of the American Transformer Company, of Newark, N. J. His headquarters are with the Western Electric Company, Chicago, Ill.

Charles L. Edgar, of the Edison Electric Illuminating Company, of Boston, returned several weeks ago from a summer trip to Great Britain and the Continent.

De Lancey Rankine has been made treasurer of the Niagara Power Company. Mr. Rankine is a brother of the late W. B. Rankine and has been connected with the corporation for some time.

F. C. Bates, one of the representatives of the General Electric Company in New York City, was married on October 19, in Brooklyn, N. Y., to Miss Augusta Engenia Lazelle Hinrichs, daughter of Mr. and Mrs. F. W. Hinrichs, of that city.

President Blood, of the National Electric Light Association, has appointed James I. Ayer to report on the progress of electric heating at the next convention of the association, to be held in May or June, 1906. The report made by Mr. Ayer on this subject at the Denver meeting last June, attracted much attention and was very fully discussed, both report and discussion showing clearly how much can be done in the way of getting new business by demonstrating the comfort and convenience, as well as the economy in many cases, of the use of various household utensils operated by electric current. This industry is constantly advancing in efficiency and variety of apparatus, and Mr. Ayer's next report will be looked for with interest. It is interesting to note that one or two of the larger stations in the association have recently established an electric-heating department with the object of pushing that branch of the industry. The Edison Electric Illuminating Company, of Brooklyn, may be mentioned as an example. Such a department would be proportionately valuable in smaller stations.

K. B. Thornton, operating manager of Messrs. J. G. White & Company, of New York, has been appointed manager of the Nassau Light & Power Company at Roslyn, Long Island. This Company is managed and operated by J. G. White & Company.

Arthur Warren has resigned his position as manager of publicity for the Allis-Chalmers Company, of Milwaukee, and will sail for Europe on November 25 on an important journalistic mission. The Allis-Chalmers department of publicity will hereafter be conducted under the management of W. S. Heger, assistant to President Whiteside.

W. H. Blood, Jr., president of the National Electric Light Association, has appointed as the association's committee on public policy, Arthur Williams, chairman; Samuel Scovil, of Cleveland, Ohio; Ernest H. Davis, of Williamsport, Pa., and Guy E. Tripp, of Dallas, Texas.

Philip P. Barton has been appointed general manager of the business and operations of the Niagara Falls Power Company and the Canadian Niagara Power Company. This appointment also includes that of general manager of the Niagara Junction Railway Company, and of the Niagara Developing Company. Mr. Barton graduated from Cornell University in 1886, with the degree of Ph. B. After two years of postgraduate work in electrical engineering he received from the same institution, in 1888, the degree of M. S. His professional career was begun in the electrical department of the Cambria Iron Company, at Johnstown, Pa. After several months of practical experience there and with the Allegheny County Light Company, of Pittsburg, Pa., he joined the engineering force of the Westinghouse Electric & Manufacturing Company. For several years he was engaged in installing electric lighting and power plants in various parts of the country, mainly in the South and the West. In 1892 he entered the service of the Brush Electric Company, of Cleveland, Ohio, in charge of engineering and sales at its Pittsburg office. After the closing of that office in February, 1898, he was connected for some months with the Pittsburg office of the General Electric Company. In September, 1898, he became assistant superintendent of the Niagara Falls Power Company at Niagara Falls, and two years later was made superintendent of the operating department of the same company. In July, 1905, he was appointed superintendent of operation of the Niagara Falls Power Company and of the Canadian Niagara Power Company, which positions he has held until his present appointment. Mr. Barton is an active member of the American Institute of Electrical Engineers.

PHILIP P. BARTON

R. S. Hale has been appointed general agent of the Edison Electric Illuminating Company, of Boston, in charge of the commercial department. He has resigned his position as engineer of the Mutual Boiler In-

surance Company, and will devote his entire energies to the new work.

George A. Damon, managing engineer of the Arnold Company, of Chicago, has been awarded the Chanute medal for 1904 by the Western Society of Engineers for the best paper on an electrical egineering subject presented to the society during that year. This paper, which was on the subject "The Opportunities in the Electrical Business," created wide-spread comment at the time it was presented, and resulted in the most crowded house the society ever had on the evening it was discussed.

Obituary

J. A. Fay & Egan Co., the well-known woodworking machinery firm of Cincinnati, Ohio, have lost one of their great designers, Harry Smith Spencer, who recently died very suddenly at his home in Cincinnati. Mr. Spencer was not exactly their head man, but was tending that way very much. He was brought up in their employment and never was enticed away by any other firm. He knew all the old and new patterns and drawings of the firm, and his twenty years' experience made his services invaluable. Regarding Mr. Spencer's ability, Thomas P. Egan, the president of the company, says:—"There was no man his equal in the United States, or we would immediately hire him. Designers of his calibre are scarce, as his ability amounted to absolute genius." Mr. Egan despairs of finding a young man to fill the vacancy, and will probably have to grow another. He is open, however, for negotiations or proposals from any one in this country.

John I. Sabin, president of the Pacific States Telephone & Telegraph Company, died October 10, after an active career in the telephone and telegraph business of the United States. In 1866 he left the East for California, having already become well known for his work in telegraphy, and there accepted the position of manager of the Western Union Telegraph Company's supply department. He was afterward promoted to the position of superintendent of the American District Telegraph Company. Becoming interested in the development of telephony, he established several classes of telephone service in California, and from that amassed a considerable fortune. Later on, together with Mr. Glass, vice-president of the Pacific States Telegraph & Telephone Company, he took up the development of the telephone and the telegraph in the Philippine Islands.

Horace Winfield Wyman, of the firm of Wyman & Gordon, Worcester, Mass., died on October 11, after a three weeks' illness of typhoid fever of a very severe type. He was 44 years of age, having been born in Worcester, May 30, 1861. Mr. Wyman was the only son of Horace Wyman, for many years associated with the late George Crompton in the Crompton Loom Works, and at present consulting engineer of the Crompton & Knowles Loom Works. He received his early education in the Worcester public schools and at the Worcester Academy, and entered the Worcester Polytechnic Institute with the class of 1881, but on account of trouble with his eyes graduated in 1882, taking his degree of bachelor of science in the department of mechanical engineering. In 1883 Mr. Wyman formed a partnership with Lyman F. Gordon, who had graduated from the same institution in 1881, to engage in the manufacture of drop forgings, a product which was then in its comparative infancy. The firm made its start in a small building on Bradley street, Worcester, occupying two rooms, one as the forge shop, the other for machine work. From this modest beginning the business grew to large proportions, until it now has a large plant in Worcester, together with branch works at Cleveland, which were established in 1903 to take care of the Western trade. The firm is one of the best known and one of the most important in its line in the country, having won a high reputation among users of drop forgings.

Large Gas Engines for Electric Railway Work

By ARTHUR WEST, Chief Engineer of the Westinghouse Machine Company

From a Paper Read at the September Meeting of the American Street Railway Association

THE following remarks are applicable to large-size gas engines only. The smaller sizes are unsuited to important electric railway installations on account of first cost, multiplicity of parts and greater expense for attendance, etc. The tendency of the modern plant is constantly in the direction of large size units. This is indicated by the rapid increase in the size of steam turbines installed in modern stations. Similar reasons will, it is believed, cause a demand for large-size gas engines for electric railway work in conjunction with producers to operate them.

One of the most important considerations in the design of large gas engines is the arrangement of the cylinders. In a single-cylinder, single-acting 4-cycle engine an explosion takes place once in every two revolutions. In order, therefore, to get the same rotative effect as with a double-acting steam cylinder, it is necessary to work four single-acting cylinders on the shaft or two double-acting gas cylinders tandem on one crank pin. With this arrangement four explosions are obtained in two revolutions, or an explosion every 180 degrees of crank angle. In case of a misfire or premature ignition due to bad gas, the crank has to move only half a turn before another explosion takes place. In the single-cylinder single-acting engine the crank must move two whole turns before the next explosion, while with two single-acting cylinders opposed to each other, or one double-acting cylinder the crank may be required to move one and one-half turns before the next explosion. The relative evil effects of a premature or misfire are, therefore, in the following ratios:—

Two double-acting cylinders	1
Two single-acting cylinders, oposed type	3
One double-acting cylinder	3
One single-acting cylinder	4

Gas engines and producers to be commercially successful must be designed to be run with the same class of help as is employed on Corliss engines and boilers. This being the case, misfires and prematures are liable to occur occasionally, and the designer must minimize their possibilities for evil. These considerations, as well as the capacity for caring for heavily swinging railway loads, have caused the Westinghouse Machine Company's adoption of tandem double-acting cylinders for railway work.

It is sometimes argued that cylinders so arranged are inaccessible. If, as is the practice of the Westinghouse Company, ample space is arranged between the cylinders, and if the inlet and exhaust valves are not

located in the heads, but in the cylinder body and entirely above the floor level, such a gas engine is as accessible as a tandem compound Corless engine or as a Corliss engine driving an air compressor.

The speed of a gas engine must be adapted to the kind of generator to which it is to be directly connected. In a general way, its speed will usually somewhat exceed that of a Corliss engine of the same cylinder dimensions. In my experience, the speed of large steam engines is limited by the inertia and consequent wear and tear of the valve gear, rather than by the inertia of the reciprocating parts themselves, which is absorbed by the compression. Inasmuch as in a 4-cycle gas engine the valve gear moves at only half the speed of the engine, somewhat higher speeds are permissible than would be the case with a steam engine having the same dimensions of cylinders.

The speed regulation adopted for large Westinghouse gas engines is especially suitable for generator driving in that no conditions of changeable load or variable friction of valve gear affect the regulator. The Westinghouse gas engine regulator governs the speed by means of a relay cylinder, and, therefore, produces results similar in type to those obtained with the relay governor used by the Westinghouse Company on steam turbines. The advantage of such a relay governor with the gas engine is that the varying friction of valves with different qualities of gas does not affect the sensitiveness of the governor. Without a relay cylinder the only way in which this result can be accomplished on large gas engines is by some form of a drop cut-off controlling the gas. This is objectionable on a gas engine, as any slight change in the speed of the dash pot very seriously affects the mixture of gas and air, with corresponding bad effect upon the regulation. Such small changes in speed of dash pots are frequent in a Corliss engine, where they cause no bad results. The Westinghouse arrangement employs no releasing gear of any kind, but secures all the advantages of regulation without its use.

The question is frequently asked as to whether large gas engines will drive A. C. generators successfully in electrical synchronism or "parallel." This has been done for several years past in Germany with entire success, and it has also been done in a number of instances very successfully by our company. We have at the present time orders for several such plants on our books, one of which is to drive an electric railway from Warren, Pa., to Jamestown, N. Y.

It is sufficient for our purpose to observe here that the cyclic variation, i. e., the degree of departure from absolutely uniform rotation, is sufficiently small to conform with the design of generators now built for steam driving.

The European designer of gas engines has allowed himself an amount of complication in valve gear which would not be permissible under American operating conditions. The successful American machine must be as nearly "fool proof" as the large Corliss engine. If it is not, it will fail to be a success from the purchaser's point of view—no matter what thermal efficiency may be claimed by the builders—as a consequence of such complication as the European engineers have been prone to adopt. In the designing of valve gear for large gas engines, wide range of quality of gases must be considered. In this respect the design of the gas engine is very different from that of a steam engine, inasmuch as the steam used has practically constant characteristics, differing only in such minor points as pressure and superheat. With the different kinds of gas to be met with, however, the proportions of air and gas, and sometimes of compression, are radically different, and no gear can hope to be a universal success which does not provide for meeting the widely varying conditions to be encountered in the market.

We are frequently asked, "What is the overload capacity of your gas engine?" A clear understanding on the part of the purchaser of the limitations in this direction is very desirable, from the point of view both of the buyer and the seller. A gas engine and producer are thermally very much more efficient than a steam engine and boiler. It is, perhaps, not amiss to say that, with a well-designed producer and gas-engine plant, a horse-power can be delivered with one-half the cost of fuel that is possible with a well-designed steam-engine plant. The power of the gas engine, however, is limited by the total volume of explosive mixture which can be drawn into the cylinders during the suction stroke, compressed and finally ignited. This condition sets a limit which does not allow of a large temporary increase of the power. Overload capacity is, of course, convenient for the purchaser, but it is unobtainable on a gas engine, unless the engine is largely under-rated, and the purchaser should consider that this is one of the prices that he pays for the enormously increased output obtained with the gas engine per pound of coal.

The overload capacity is, therefore, simply the amount which the builder rates his machine below its ultimate capacity. It has been our practice to rate our gas engines in such a way that they would have a safe overload capacity of 10 per cent. Our machines are ordinarily good for somewhat more than this, but conservative engineering requires that there be a margin of power in order that overloads may not materially reduce the speed. The above remarks on overload furnish a general guide which may be of service in selecting suitable generator capacity for a gas engine. For ordinary cases the overload capacity of the generator and that of the gas engine should be about equal, although the gas engine will indefinitely carry its overload while the generator will not, in all cases, unless it is bought with that understanding.

The mechanical efficiency of a large gas engine is very much greater with a 4-stroke cycle than with a 2-stroke cycle, this being one of the arguments against the 2-cycle engine. It is no uncommon thing to see 2-cycle engines which do not realize as brake horse-power more than 60 per cent. of the work actually done by the combustion in the cylinders. The efficiency of a 4-cycle engine varies considerably, but it may be said in a general way that a well-designed engine will deliver about 85 per cent. of the gas indicated horse-power in the form of brake horse-power. This 15 per cent. of power lost is not exclusively composed of frictional resistance of journals, crosshead slides, etc., as is the case in a steam engine. The 4-cycle engine has, of course, to draw in its own mixture of air and gas and compress the same, and its functions, therefore, combine those of a pump, a compressor and a motor. It is the pumping and compressing work which causes the mechanical efficiency of the gas engine to be somewhat lower than that of a steam engine. The actual friction of the working parts need be no greater than with a well constructed Corliss engine, viz., 90-95 per cent. In order to keep down the friction and increase the reliability of the machines, it is the practice of the Westinghouse Company to design large gas engines with provisions for attaching a continuous return oiling system. The large amount of oil put through the journals increases the safety, requires less attendance and keying up,

and washes out dust if the engine is required to operate in an atmosphere which is not clean.

The thermodynamic efficiency of the gas engine varies so much with different kinds of gas that it is hard to say just what the average value would be. It is probably not far from the truth, however, that its thermal efficiency is about 25 per cent., though in favourable cases gas engines have obtained efficiencies well over 30 per cent.

There is an impression rather prevalent that a gas engine is uncertain and hard to start. A properly designed engine, supplied with fairly decent gas, can be started as easily as a steam engine. Large Westinghouse horizontal gas engines are started by means of compressed air, the only operations required being (1) to open the main gas valve; (2) close the igniter circuit; (3) open one compressed air valve, similar in construction to an engine throttle. The compressed air puts the engine in motion, which draws the charge into the cylinders and compresses the same, after which the first explosion takes place. Air is shut off and the engine is in full operation. We find no more difficulty in starting our gas engines than a steam engine of comparative size. I desire to lay stress on this point, as one of the stock arguments against the gas engine is that it is difficult to get into operation.

With certain kinds of gas, inspection of the interior parts of the cylinders is often desirable at regular intervals of, say, a couple of months. This is especially the case with blast furnace gas, and also with producer gas made from certain kinds of fuel. We have taken particular pains to arrange our cylinders so that no parts of the valve gear or valves are below the floor. The inlet valves being located directly on the top of the cylinder, easy access can be had to either end of either cylinder by removing the inlet bonnets. The exhaust valves are also a part of the engine which need occasional attention for regrinding. Especial care has been taken to render these quite easily removable. The cylinders are, therefore, directly accessible from the top through the inlet openings and from the bottom through the exhaust openings. The fact that all the valve parts are entirely above the floor line renders these operations much easier than if a large part of the valve gear extended downward into foundation parts. It is not necessary to remove the cylinder heads, except to examine the piston rings themselves, which is not often required. Inasmuch as clean gas cannot always be secured, the importance of such easy entrance to the gas cylinders cannot be overestimated.

The large-size gas engine has come to fill such an important place in Europe, and has there proven itself to be so reliable and serviceable, that there is no question about its being adopted in this country in the near future, in a form suited to American operating conditions.

Electric Railways in Germany

A REPORT given in a recent number of the "Elektrotechnische Zeitschrift" shows the growth of electric railways in Germany since 1896, as follows:—

	1896.	1900.	1903.	1904.
Number of main centers of electric railway systems	42	99	134	140
Length of roads in miles	361.4	1781	2292.7	2354.2
Length of single track in miles	530.3	2641.7	3415.5	3521.1
Number of motor cars	1,571	5,994	8,702	9,034
Number of trailers	989	3,962	6,190	6477
Capacity of electric machines in kilowatts	18,560	75,608	133,151	133,326
Capacity of storage batteries in kilowatts	.....	16,890	38,736	39,809

Electrolytic Calcium

BY an electrolytic process similar to that now so successfully used in the reduction of aluminium ores, the metal calcium, which has undergone a long period of experimentation, is now being produced in commercial quantities.

In the process as carried out in Germany the molten metal is formed at the cathode terminal of an electrolytic chamber. There is a large demand for the metal in connection with the hardening of steel and it is thought that it will serve many useful purposes. The price of the metal has been reduced from $280 per ounce in 1903 to a present value of 37 cents, or less than one-seventh of 1 per cent. of the former figure, and indications point to a still further reduction in the near future. This great saving in cost is attributed to the success of the new process of production.

A project is on foot looking to the substitution of electricity for steam on the line running from Nice to points along the Italian frontier. The fact that there are a number of tunnels along the route is a special feature in the determination. There are several large hydraulic plants in the region, and opportunities exist for installing others, so that the electric power could be readily obtained.

Electricity in Ore Dressing

IN discussing recent progress in ore-dressing "Electrochemical and Metallurgical Industry" says:—The magnetic separator developed for the iron business could not succeed in face of discoveries of the cheap Mesabi ores. But it has been intelligently applied to the zinc ores of the Franklin mine, New Jersey, and has greatly enhanced the money value of that large deposit. It has also been applied with success to the complex zinc ores of the Rocky Mountains and Wisconsin. Copper ores are often well treated by it, and, in fact, it has found a wide range of application in the whole field. Its rival and co-operator, the electrostatic generator, has been made also a practical machine. The "Blake-Morschler" electrostatic separator is used in commercial work in large mills in Denver, Park City, Butte and Wisconsin. It is a distinct success. Very favorable reports are heard of another electrostatic separator, the "Dolbear," developed in Boston, which is a bold innovation, in using the high-tension transformer instead of the electrostatic generator for the exciter of the separator. This machine has been evolved from the laboratory stage by the aid of some distinguished electrical engineers. The Elmore oil separator has a peculiar sphere of action in the ore-dressing field. Some minerals are easily "wet" by crude oil and some are less easily affected. Such so-called "grease processes," of course, can be nicely applied where everything else fails. One of the original grease processes was discovered at the Kimberly diamond mines by a boy, who, while eating his lunch at work, accidently dropped a piece of bread, "butter-side down," on the travelling belt on which the diamond-bearing clay passed. He found that where the grease was, there also were the diamonds. For some time this youngster enjoyed "easy money," and was finally only persuaded for a consideration to tell his secret.

The cost of the entire plant of the Municipal power station at Hanover, not including the cost of the conductor system, the transformer stations, and the dwelling rooms for employees, is about $180 per kilowatt.

The Manufacture of Calcium Carbide

The Soo Plant of the Union Carbide Company

By I. R. EDMANDS, E. E.

THE Soo plant of the Union Carbide Company is situated at Sault Ste. Marie, Mich., on the banks of the St. Mary's River. The industry of manufacturing calcium carbide is an electrochemical one, and was located at the Soo primarily on account of the large power development there, which was made by the Michigan Lake Superior Power Company.

It would doubtless be astonishing to most people not connected with the carbide business to know the extent to which it has developed in the past six years, and that two large and costly plants, one at Niagara Falls, N. Y., and the other at Sault Ste. Marie, Mich., are now manufacturing calcium carbide.

The Soo plant, in its different buildings, has a total floor space of 288,000 square feet. There are now installed electric generators having a capacity of 12,000 H. P., and additional generators of 10,000-H. P. capacity will be required to complete the plant, making an ultimate capacity of 22,000 H. P.

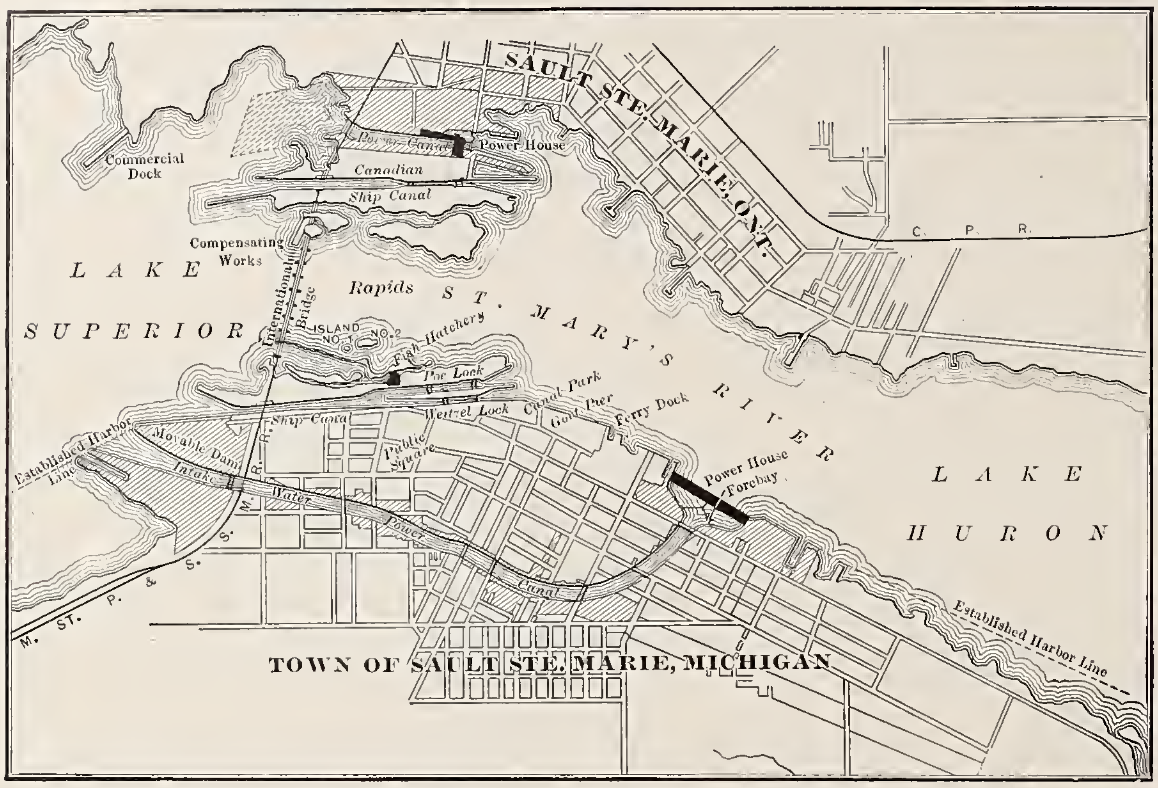
The induction motors installed for the different mechanical operations have a total of about 1500 H. P.

The business has attained its present proportions principally from the consumption of calcium carbide in the production of acetylene to be used in lighting country homes and buildings not accessible to city lighting systems, as acetylene lighting is particularly well adapted for such purposes.

The uses of acetylene are, however, manifold, and the number is rapidly increasing. Large quantities of calcium carbide are now used in central town lighting plants, from which acetylene is distributed through a system of street mains and services, giving the small town a gas plant with all the advantages which the coal gas plant offers in the larger cities. Acetylene is used for lighting public institutions of all kinds, for illuminating railway cars, power and sailing yachts, in locomotive headlights, for automobile lighting, government lighthouses, beacons and buoys, for heliographing, in army field hospital service, for portable table, bicycle and carriage lamps, and is rapidly coming into general use also for cooking purposes.

Recent experiments at Cornell University prove that plant growth continues as rapidly under acetylene light as by daylight, and advantage

THE POWER HOUSE AND FORE-BAY OF THE UNION CARBIDE COMPANY, SAULT STE. MARIE, MICHIGAN



MAP OF THE SAULT RAPIDS, SHOWING THE POWER CANAL AND THE LOCATION OF THE POWER HOUSE

is being taken of this fact to make hothouse vegetables and flowering plants work both day and night. The advantages to the horticulturist are self-evident. The rapid growth of the industry is due largely to the perfection of automatic generators for isolated lighting plants, which require very little and infrequent attention, and to the ease of operation and the comparatively low cost of the installation itself, as well as the superior quality of acetylene light and its economy as compared with other artificial illuminants.

On account of the extent of the industry at the Soo, the company has purchased and operates a limestone quarry, lime kilns, coal trestle, ship unloading devices, locomotives, steel drum factory, and machine and forge shops, and also owns and operates the dynamos which furnish electric power for the furnaces. The company further owns and controls the fundamental patents on calcium carbide, the process of manufacturing it, and on the furnaces and appliances used in its manufacture.

The power development at Sault Ste. Marie, Mich., was begun in the year 1898, by the Michigan Lake Superior Power Company. The canal is about 12,000 feet long, 200 feet wide and from 23 to 25 feet deep. It takes water from the St. Mary's River above the government locks, at the outlet of Lake Superior, and after passing through the city, empties into the river again below the rapids.

The power house is located along the water front at the lower end of the canal,. and has a mechanical power output at the turbine shaft of approximately 45,000 H. P., with an

AN AUTOMATIC COAL LOADER EMPLOYED AT THE PLANT OF THE UNION CARBIDE COMPANY

THE DYNAMO ROOM

effective head of 16 feet, using about 30,000 cubic feet of water per second.

The canal was cut through rock for about one-third of its length, the balance of the excavation being through earth. Where earth was encountered, the canal was entirely lined, both on its sides and bottom, with heavy planking below the water line. Channellers were used along the sides of the canal in the rock cut, leaving the sides smooth, thus offering slight resistance to the flow of the water.

The hydraulic equipment consists of eighty penstocks, each having two pairs of 33-inch water wheels on a horizontal shaft which extends through a bulkhead for direct connection to the generators.

The Carbide Company has now installed nineteen 500-H. P., single-phase, low-voltage generators; two 500-H. P., two-phase, 220-volt generators; one 500-H. P. generator, which can be run as a low-voltage, single-phase generator, in parallel with the generators supplying the furnaces, or as a 220-volt, two-phase generator, which can be run in parallel with the generators furnishing power for the motors and lights. There are also two 500-H. P. direct-current generators for exciting purposes.

One novelty in the plant which may be of special interest is the generator, which can be run in parallel with the low-voltage, single-phase generators or the higher voltage, two-phase generators, used to supply power for the motors and lighting circuits. This, as well as the other generators, has a stationary armature and revolving fields, and is wound in the same manner as the other 220-volt, two-phase generators. One phase, however, is divided into sections, and means are provided so that the different sections can be connected in multiple, allowing the generator to give its full output on one phase when connected in this manner. The change from one circuit to another is accomplished by having two separate switchboards. No changes in the connections have to be made, and the only precaution necessary is to leave the switches on one board open while the other is being used. By this arrangement, the generator can ordinarily be used in connection with the furnace load, but in case an accident occurs to either of the two-phase generators, it can be connected to that circuit as a spare unit.

Another rather novel feature of the electrical installation is the special switch, located on the switchboards of the low-voltage generators, having a capacity of 3000 amperes. Under ordinary circumstances, a switch having this capacity, with the normal current density per square inch of contact surface, would be inconveniently large and cumbersome, making it difficult to operate.

To obviate this difficulty, as well as to reduce expense, an arrangement was designed to clamp the clips after the switch is closed, by simply twisting the switch handle, the clamping being effected by two wedges on the handle spindle, one having a left and the other a right-hand thread. When the handle is turned, the wedges are forced apart and the switch clips are clamped tightly in place, resulting in a much larger possible current density per square inch and a corresponding decrease in size of switch.

There are induction motors in-

INDUCTION MOTORS IN THE GRINDING DEPARTMENT

A TWO-PHASE ELECTRIC DERRICK CAR USED IN THE MANUFACTURE OF CALCIUM CARBIDE

stalled in the plant, having a total capacity of about 1500 H. P., and the sizes range from 5 to 50 H. P. each. They are of the standard 220-volt, two-phase induction type, and are supplied through specially constructed three-wire, paper-insulated, lead-covered cables.

The auto-starters for the induction motors were specially designed to meet the severe conditions that are imposed at this plant. The cases are dustproof and the electrical contacts are immersed in oil. The controller handle is arranged so that it must be held in the starting position during the time of starting, otherwise it will automatically return to the "off" position. It was designed in this way because experience proved that it was most difficult to make unskilled men properly start motors. Occasionally a motor would be left running with the auto-starter handle on the starting position, which would result in overheating, and possibly destroying the windings of both the auto-starter and motor, but with the new design trouble of this kind cannot occur.

An automatic central telephone system is used, so that quick and convenient communication can be had between all parts of the works.

The plant is completely equipped with conveyors, elevators and labour-saving devices, in order that the large quantities of raw materials and finished product can be handled with the minimum amount of manual labour. The raw materials used in the electric furnaces are properly prepared and carefully mixed in the correct proportions, so that the calcium in the lime will have the right amount of carbon to make the chemical combination complete, as expressed by the following equation:—

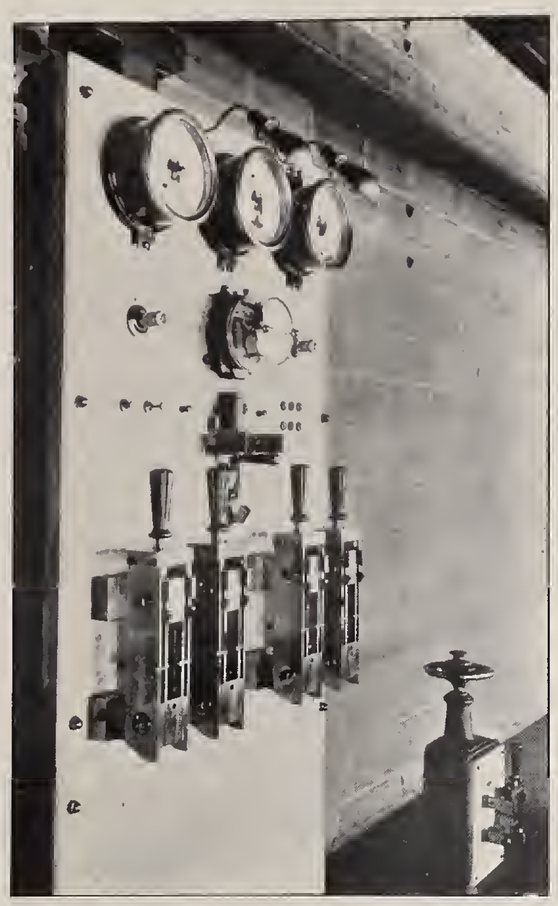
$$CaO + 3C = CaC_2 + CO.$$

It is obvious that the reduction of calcium oxide, which is one of the most refractory compounds known, and the subsequent recombination of calcium with carbon, the result of which is an endothermic compound, requires in the first instance not only the high temperature of the electric furnace, but a great quantity of heat to overcome the chemical affinity existing between the calcium and oxygen; and in the second instance, heat is absorbed and energy stored.

After the carbide is taken from the electric furnace, it is crushed and screened, and the various standard sizes, ranging from "lump" down to a size as fine as granulated sugar, are packed in hermetically sealed metal packages, ready for shipment. The larger sizes are generally used in acetylene generators, while the smallest size is used for automatic table lamps, which are coming into common use.

Nearly all of the carbide made is shipped in steel drums holding 100 pounds each. These drums are used only once, and a large department is required for their manufacture.

The lime kilns are of the most modern design and have many points



A LOW-VOLTAGE SWITCHBOARD WITH SPECIAL CLAMPING SWITCHES EMPLOYED BY THE UNION CARBIDE COMPANY

similar to modern blast furnaces. They are steel shells, 60 feet high, lined with firebrick, and instead of burning wood or coal, are adapted for the use of producer gas, which is made in an adjacent plant.

The limestone is obtained from the Carbide Company's own quarries, located about 70 miles west of the Soo, in the woods, several miles from the nearest town. The quarry is operated during all seasons of the year and the stone is shipped to the carbide plant by rail. The Carbide Company erected a number of buildings at its quarry, including cottages and houses for the workmen, and every effort has been made to make the buildings comfortable and thoroughly sanitary. All the buildings and houses are supplied with pure water from artesian wells driven through the rock formation, and a complete sewerage system and a central heating system have been installed, the latter using exhaust steam from the engine operating the quarry and crushing machinery, and all of the buildings are lighted with acetylene from a single generator.

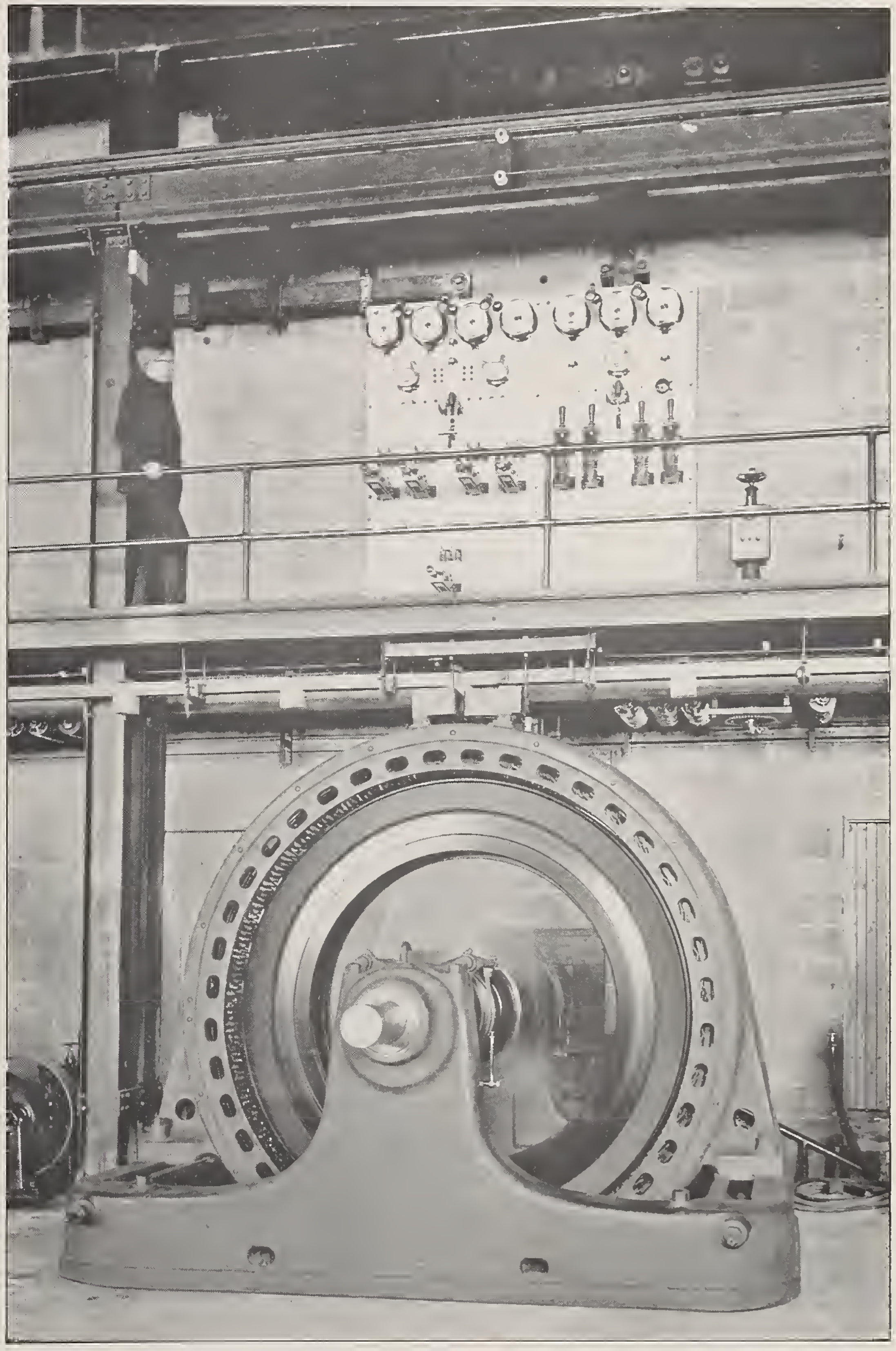
One of the largest buildings is used as a boarding house for the convenience of the employees, and is provided with a large lounging and smoking room, furnished with the current magazines and papers. There is also, in the same building, a room equipped with toilet facilities.

The manufacture of calcium carbide and the auxiliary operations already employs a large force of men, and is not only the largest of the industries at the Michigan Soo, but is rapidly expanding.

Alternating-Current Locomotives for the New Haven Railroad

UNDER the head "An Unprecedented Railway Situation," Frank J. Sprague, in a recent issue of "The Street Railway Journal," protests emphatically against the employment of alternating-current locomotive equipment by the New York, New Haven & Hartford Railroad, which, as already noted in these pages, has placed an order for twenty-five 78-ton alternating-current locomotives, to be used for trains running out of New York City.

Mr. Sprague does not object so much to the alternating-current apparatus itself, as to its employment in this particular case. For about $13\frac{1}{2}$ miles the New Haven road uses the New York Central tracks to come into the Grand Central station in New York City. As is well known, the Central is making a very extensive terminal electrification of its lines, and it is using direct current. Under these circumstances, and referring to the decision of the New Haven road to use the alternating-current locomotives, Mr. Sprague says:—



A COMBINATION SINGLE-PHASE, TWO-PHASE ALTERNATOR USED BY THE UNION CARBIDE COMPANY

"Speaking in my individual capacity as an engineer, and also from a railroad-equipment and operating standpoint, I venture to assert that under the existing circumstances, and in view of certain special limiting conditions, this decision is an error of more than ordinary magnitude. * * * Every specific condition surrounding this proposed equipment seems to militate against that directness and simplicity of equipment essential to the claim of alternating-current operation, and which, under more favourable auspices, would have a fair chance of being demonstrated."

The Gramme Monument at Liege

According to "The Engineer," of London, a monument to Zenobe Gramme was formally handed over to the Liege Municipality on October 7 by Monsieur Frederic Nyst, president of the Liege section of the Association des Ingénieurs Sortis de l'Ecole of Liege, and president of the committee of that society formed for carrying out the object. The monument, by the sculptor Vincotte, takes the form of a bronze bust of the inventor, supported on either side by stone statues representing Gramme—one at the age of eighteen following his trade of joiner, and the other in meditation on the subject of his invention.

Gramme was born in 1826 at Jehay-Bodegnée, near Huy, in the province of Liege, and he worked as a joiner at Liege between 1849 and 1855, while frequenting the evening classes of the Ecole Industriélle, where he acquired his first notions of physics and mechanics. In 1856 he removed to Paris, where he remained until his death in 1901. It was by mere chance that Gramme turned his attention to electricity. He was engaged as patternmaker at the works of the Société l'Alliance, where an electric machine, designed by Nollet, with improvements by Van Malderen, was being constructed. The treatise on physics that he possessed did not explain to Gramme's satisfaction the principle of the machines on which he was engaged, and he imagined a theory, the correctness of which he verified. This led him to propose a notable improvement in the Alliance machine. As he met with but little encouragement from his immediate superior, he offered his services at the Ruhmkorff Works, which were then celebrated for their electric apparatus, and he afterwards worked for Disdéri in London.

It was in the course of these wanderings, about 1867, that Gramme first conceived the idea of the dynamo which bears his name, at which he worked with very elementary tools. He was also fortunate in finding in M. Hippolyte Fontaine a patron, who appreciated the value of his invention and advanced the funds for a patent, which was taken out on November 22, 1869. With study, investigation, experimental trials, and combinations, Gramme devised, designed, and constructed with his own hands his first electro-magnetic machine. This practically constituted the starting point of the electric industry.

The Liege Association of Engineers, which elected Gramme an honorary member in 1898, appointed in 1903 a committee of Liege members to carry out the idea of the monument, the presidency being offered to Senator Montefiore-Lévy, founder of the Electro-technic Institute.

The public subscription amounted to nearly $15,000, and the Belgian Government, the Province of Liege, and the Liege Municipality also contributed. The monument, the architectural part of which is due to Soubre, is erected on the point of land formed by the confluence of the Ourthe with the Meuse, facing the island, part of which is occupied by the Jardin d'Acclimatation. At the unveiling ceremony, which was attended by Madame Z. Gramme and her two daughters, speeches were made by M. Nyst, chairman of the organizing committee; M. Kleyer, burgomaster of Liege; Professor Eric Gérard, of the Electro-technic Institute; M. Francotte, Minister of Industry and Work; M. Léon Janssen, president of the International Tramway Union; M. A. Habets, president of the Liege Engineers' Association, and M. Hospitalier, representing French electricians.

Some motor generator sets of an interesting character have recently been supplied to the Acton Urban District Council by the Lancashire Dynamo & Motor Company, of Manchester, England. These sets are for running off a 10,000-volt, 60-period, two-phase circuit, and are to take current from the supply mains of the Metropolitan Electric Company. They will generate direct current at 460 to 500 volts, and can deliver 550 amperes at this voltage. This is 250 KW., and full-load speed is 440 r. p m.

The Longest Through Trolley Line in New England

The longest through trolley line in New England was recently opened by the Old Colony Street Railway Company between Boston and Fall River,—a distance of 35 miles. This line connects with the steamers running between Fall River and New York, and reduces the fare charged by the steam road between Boston and Fall River, 45 cents each way. The entire cost of a trip from Boston to New York, or vice versa, by way of this route is therefore only $1.75.

This trolley line will undoubtedly become very popular, especially in the fall and during the spring and summer months. The route lies through Mattapan and the famous Blue Hill Reservation, one of the finest parks in the country, then through Randolph with its beautiful trees, and continues on to Brockton, noted the world over for its shoe industry. From Brockton to Taunton the route follows the old turnpike and goes through a portion of Easton and Raynham. Taunton Green, where the first flag bearing the device "Union and Liberty" was unfurled, is passed. Then for some distance the trip lies along the banks of the beautiful Taunton River, through Dighton, at one time the center of the shipping industry. Somerset, with its long avenue of giant elms and fine old houses built in the seventeenth century, is another town visited before reaching Fall River. At the latter place the car takes one within a minute's walk of the boat landing.

The effect upon the rails of the traction wheels of electric cars, according to "The Iron Age," is different from that of the drivers of locomotives. An engine driver can be turned in the same place for some time without injuring the rail beyond a slight burning or hardening at the point of contact. The experience of the Boston Elevated Railway goes to show, however, that if the motor wheels of a car are kept turning in one spot for any length of time they will actually cut a heavy rail in two. Cases where trains have been stalled on grades and the motors kept at work in an effort to get started have resulted in the formation in the rails of deep holes where the wheels were revolving. This has made it impossible for the train to get under way with its own power, requiring a push or pull from some outside source of power to start it.

THE ELECTRICAL AGE

Established 1883

Volume XXXV Number 6
$2.50 a year; 25 cents a copy

New York, December, 1905

The Electrical Age Co.
New York and London

A Model Power Station

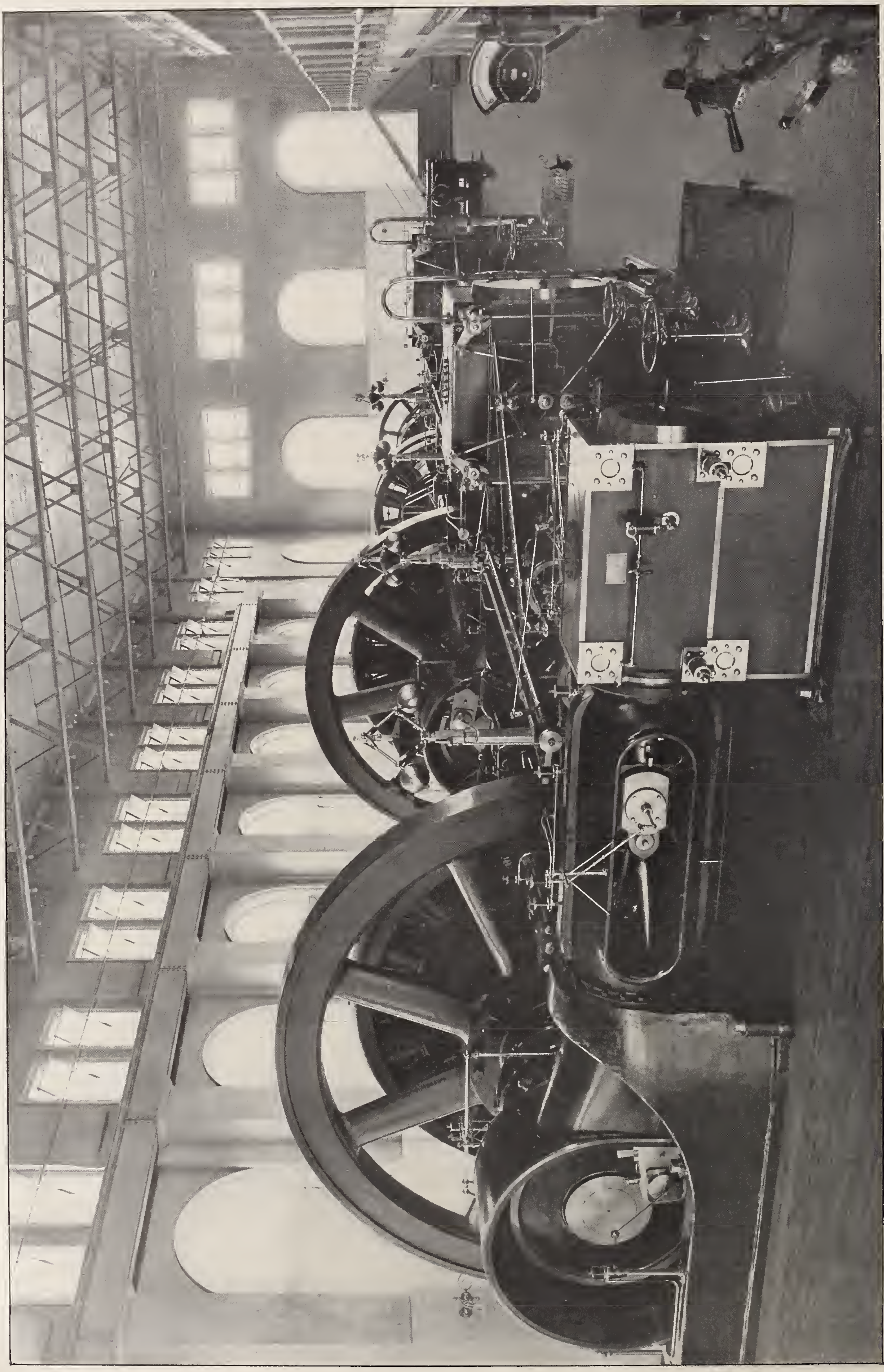
By KEPPELE HALL, E. E., Consulting Engineer of the National Cash Register Company, Dayton, Ohio

A WORKBENCH IN THE ENGINE ROOM

A NOTED Swiss engineer, who had travelled all over Europe and extensively in this country, recently remarked that at the plant of the National Cash Register Company, at Dayton, Ohio, he had seen "the most beautiful power station in the world." However accurate his remark may or may not have been, the fact remains that in this progressive institution no effort has been spared to make its power station a model of modern engineering and economic practice, and so arrange every detail of equipment as to secure the requisite output of power at the minimum of operating expense. From this, the engineering point of view, the plant is "beautiful"; and if external appearance adds to the effect, it has only been furnished as a suitable housing for a thoroughly up-to-date installation. The engine room is severely dignified in appearance, nothing gaudy detracting from the beauty of the prime movers. Above all, it is clean from its white ceiling, tiled walls, and polished floors to the merest detail on engine and generator.

The station was designed to meet the growing demands of a rapidly increasing business and to provide for future contingencies, and in order not to stop operations, the new station had to be built and the equipment moved from old to new without interruption to the manufacturing business that was going on all the time. Supplying, as it does, all the power for machinery and light, steam for heating and other purposes, water for drinking, washing and fire protection, it was necessary to employ considerable ingenuity in order not to interfere with the oper-

TRUCK ENTRANCE TO THE POWER HOUSE. THE SWINGING WINDOWS ARE FEATURES OF THE BUILDING



THE STATION INTERIOR. TWO 1200-HP. UNITS ARE SHOWN IN THE FOREGROUND

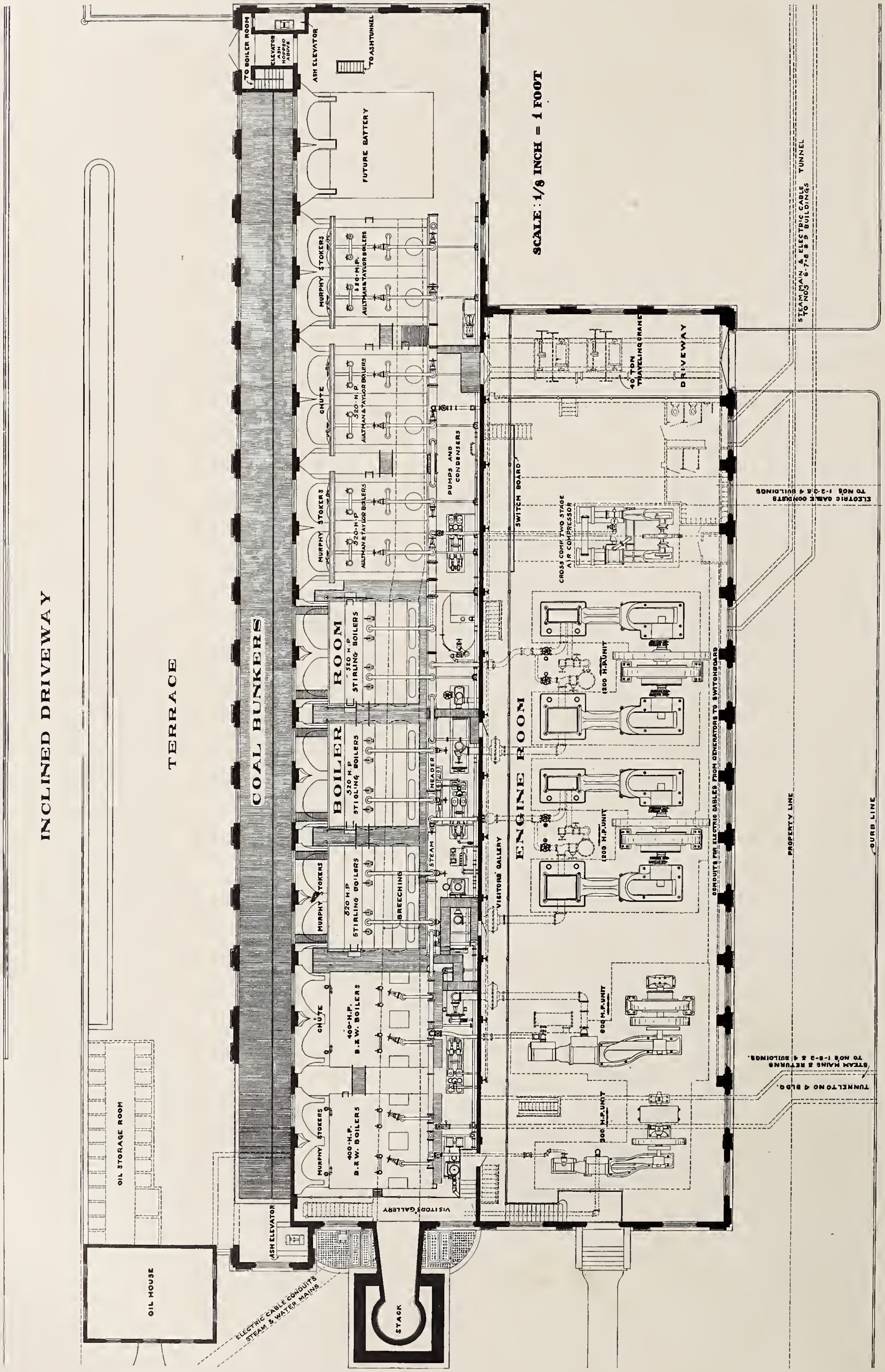
ation of a factory employing 4000 persons

For a time both the old and new stations had to be operated together, with suitable cross-connections for steam and electric power. Then the engines and boilers had to be moved from the old to the new building without any interruption of the service. Next it became necessary to add to the boiler equipment and the steam heating system; and additional pumps were provided to take care of the water supply. With these demands on the steam plant came corresponding requirements for electric power, and the realization of the fact that, in order to have some reserve in the event of damage to any of the engines and to be prepared for the increasing load, a new large engine and generator were needed. To accommodate this unit and the others, the original plans for the location of the engines had to be revised and the space originally set apart for other purposes utilized to accommodate the equipment. The first new engine was started in the spring of 1902. At the end of 1903, every foot of space in both engine and boiler room was occupied, and during the winter of 1903-04 it was necessary at times to crowd the boilers to double their rated capacity to keep up steam for heat and power. Such practice is dangerous, damaging, and far from economical, and it was clearly seen that before another winter came around the building would have to be enlarged. It is this work of enlargement, together with the finishing of the interior of the whole building, that has just been completed and is here described.

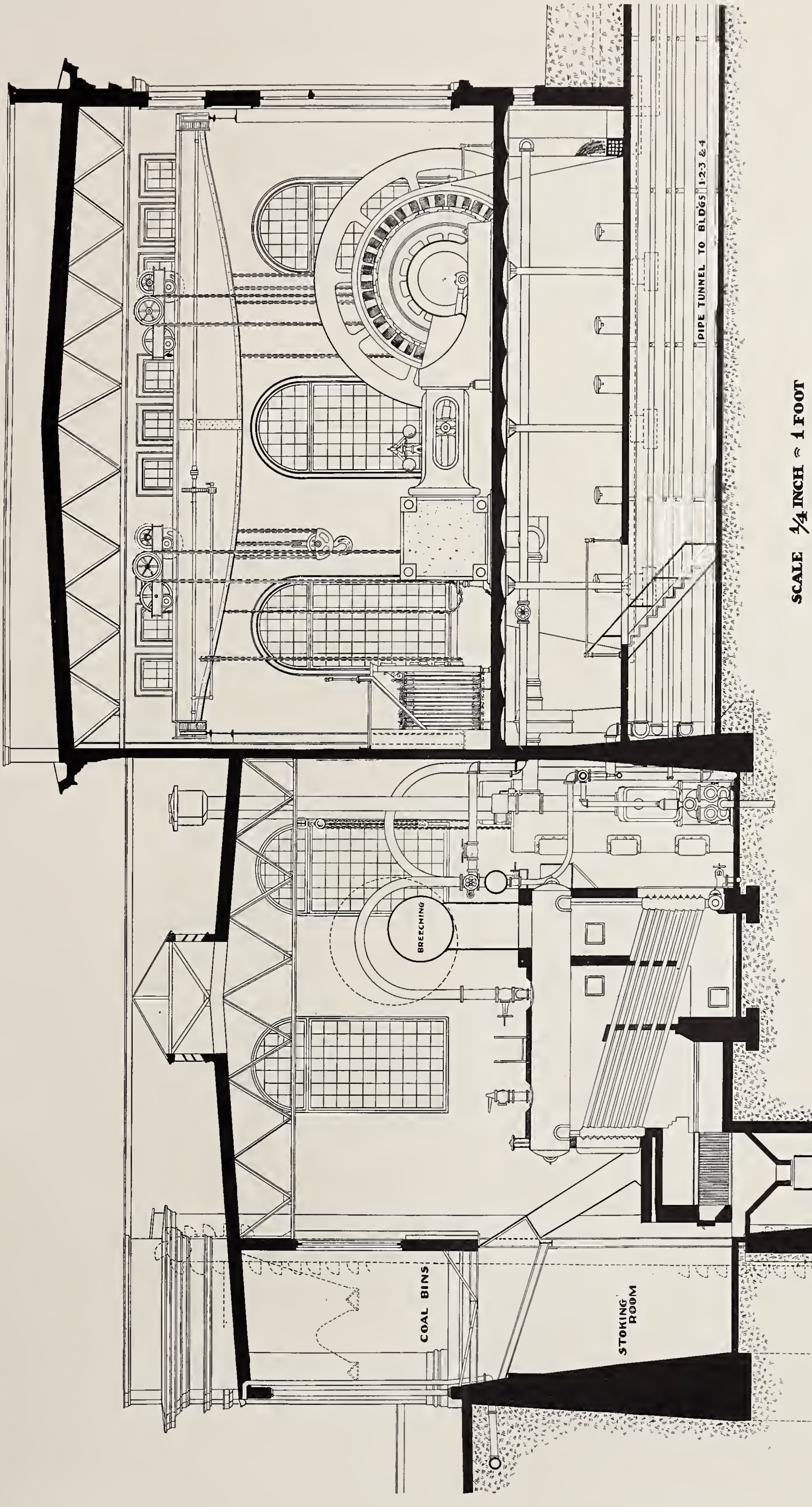
Many factors had to be taken into consideration before starting this work, for it was decided to overcome in the new additions as many as possible of the disadvantages and inconveniences that had developed in operating the original station. With all such points in mind, the company's engineering department prepared plans and specifications for the additions and alterations to the building and for the equipment to be furnished, let the contracts, and supervised the work. All of the steam header work and other steam and water piping, together with innumerable other details of construction and finishing, were done by their own departments, plumbing, electrical, millwright, woodworking, painting and outside.

The boiler room is 250 feet long, 50 feet wide and 40 feet high. It is excavated to a depth of 15 feet below grade to the boiler room floor. Below this is a further excavation of 8 feet to the floor of the ash tunnel, which runs under the mechanical stokers. Ten 8-inch artesian wells are driven to a depth of about 50 feet below the boiler room floor, and these connected through sand traps to the main suction line, which runs the entire length of the boiler room, feed all the various pumps. The boilers are fired by Murphy automatic stokers and smoke consumers, into which fuel is fed through chutes from coal bunkers overhead. The ashes drop into hoppers located directly under each furnace. These hoppers have slides in the bottom and open into the ash tunnel. An ash car running through the tunnel on tracks under the hoppers is filled by opening slides in the hoppers and is then pushed to the end of the tunnel, where its contents are dumped into a bucket conveyor which carries them to the height of the boiler room roof. There they are deposited in a large storage hopper which, in turn, is provided with bottom doors, by means of which it can be emptied into wagons on the coal terrace and hauled away. The only manual labour necessary for the removal of the ashes is that employed in pushing the car from the ash hopper to the conveyor and feeding them into the latter.

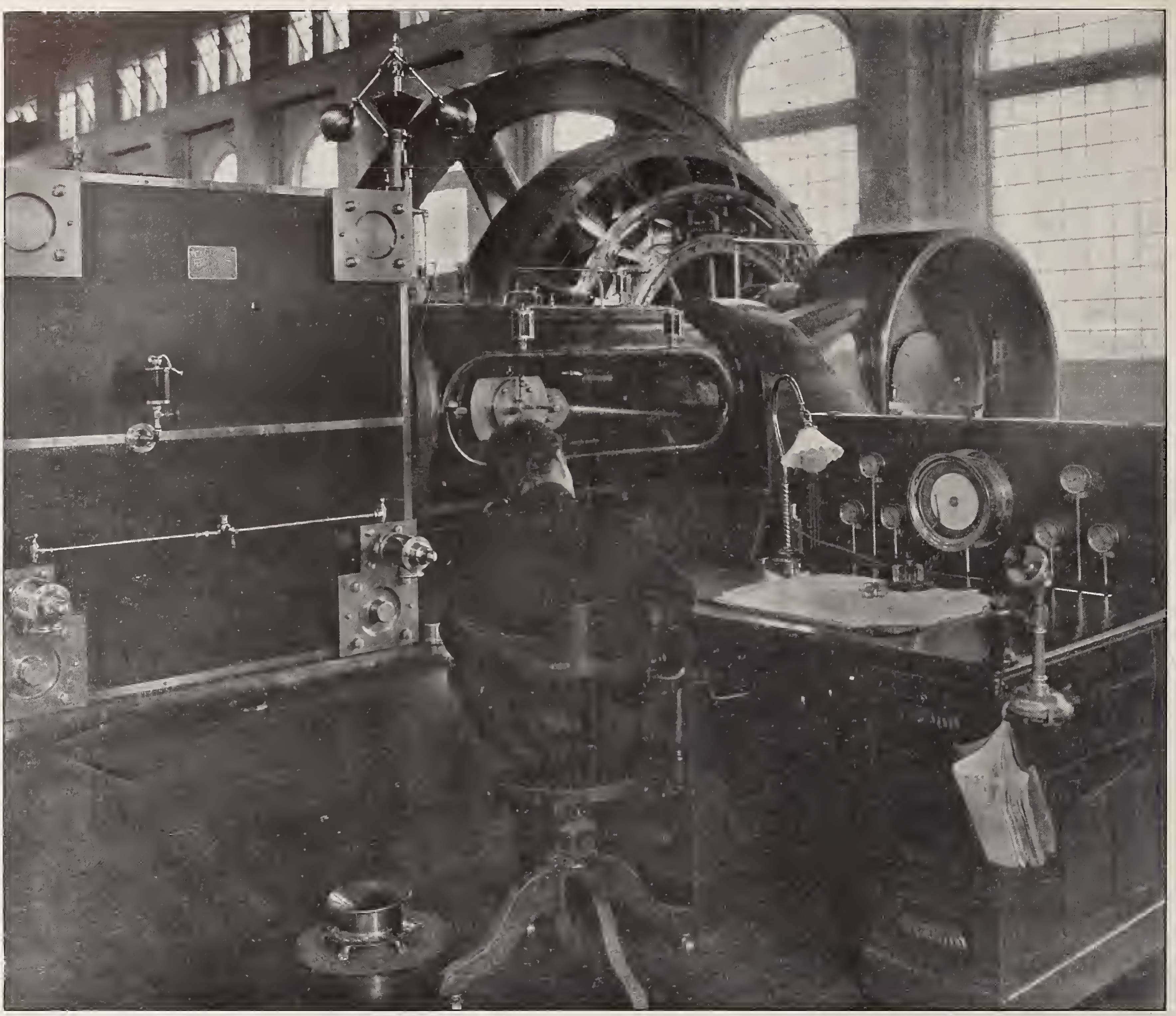
A GENERAL VIEW OF THE POWER STATION. THE CHIMNEY IS 190 FEET HIGH AND 8½ FEET IN DIAMETER INSIDE



GENERAL PLAN OF THE POWER STATION



A VERTICAL CROSS-SECTION



THE ENGINEER'S DESK, WITH RECORDING STEAM GAUGE AND SMALLER GAUGES, SHOWING PRESSURES IN THE HEATING MAINS AND IN THE VARIOUS WATER MAINS

There is space west of the boilers for the addition of another battery (500 H. P.) of boilers, and still space beyond that for the accommodation of work benches and supply cupboards.

In the southwest corner a hydraulic lift extends from the ash tunnel and boiler room floors to the coal terrace above. This is for use in removing ashes from the furnaces, the cleanings from the feed-water heater, and the taking in and out of various materials. It extends to the ash tunnel in order that it may be used for the removal of ashes, should the conveyor become damaged or disabled. An iron stairway extends from the boiler room to the coal terrace adjacent to the hydraulic lift.

A complete system of iron platforms across and around the boilers gives immediate access to all valves in case of emergency. Iron ladders connect these platforms to the boiler room floor at each battery of boilers.

The smoke flue or breeching extends over all boilers. It is 9 feet in diameter where it enters the stack and 5 feet at the last boiler. To overcome the intense heat given off by this flue and to somewhat improve the draft, it has been covered throughout its entire length, first with a sheathing of corrugated galvanized iron, and then with asbestos air-cell blocks cemented over with asbestos cement, the whole being covered with muslin and painted. This covering insulates the breeching so that one can comfortably place his hand against it. The smokestack is 175 feet high from grade line, or 190 feet from boiler room floor and $8\frac{1}{2}$ feet in diameter inside.

The room contains the following equipment:—

Sixteen water-tube boilers fitted with automatic stokers, aggregating 3800 rated boiler H. P., and capable of developing 5500 H. P. if required. Steam pressure, 150 pounds.

One 5000-H. P. feed-water heater and purifier.

Three boiler feed-water pumps.

One pump for circulating warm water throughout the various buildings.

One 1000-gallon "Underwriter's" fire pump.

One drinking-water pump.

One return pump on heating system.

Two vacuum pumps on heating system.

One drip-line return pump.

Two 1200-H. P. surface condensers.

One 600-H. P. surface condenser.

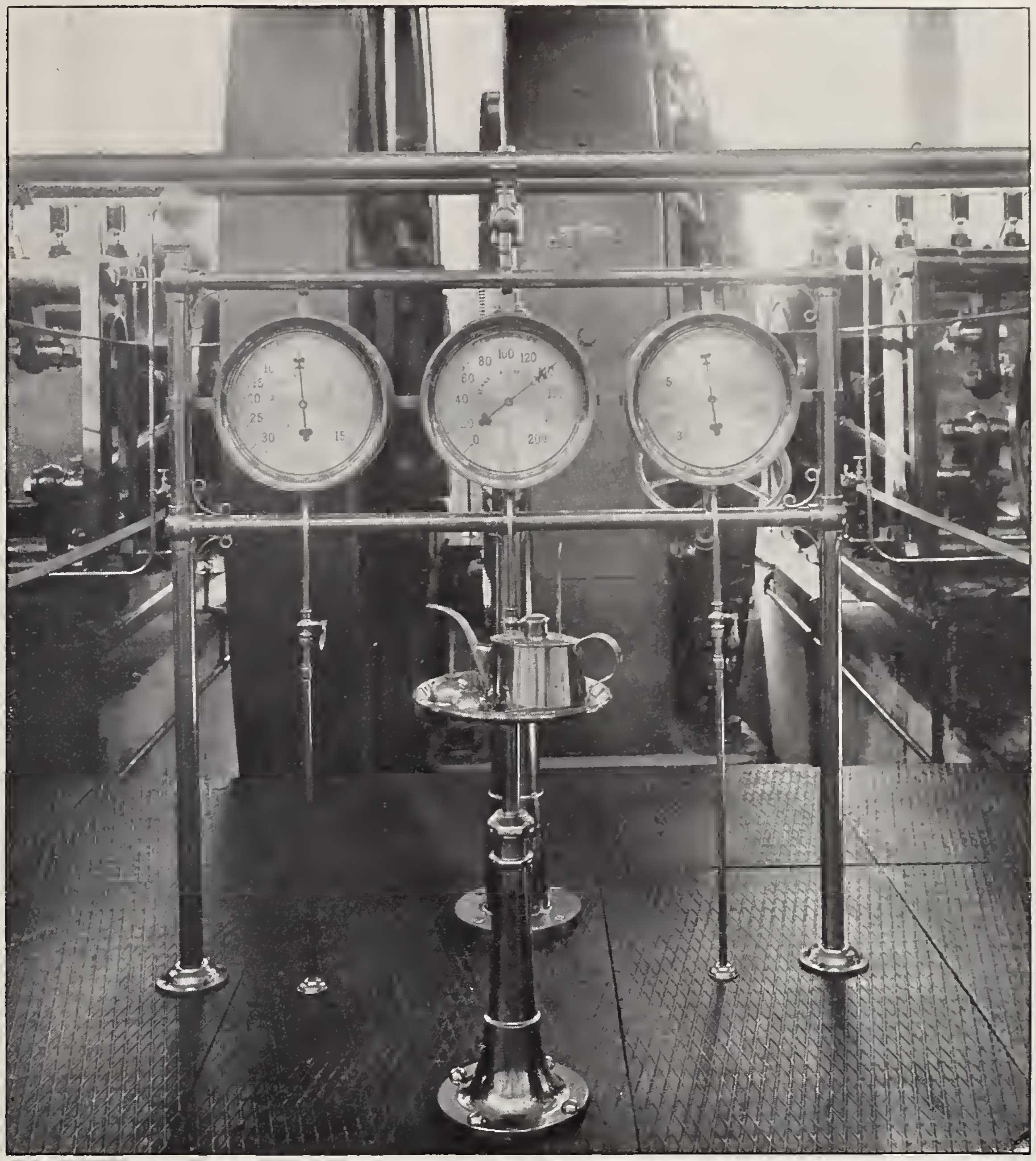
One 300-H. P. surface condenser.

One 15-H. P. engine and generator for furnishing lights in power station when the engine room shuts down.

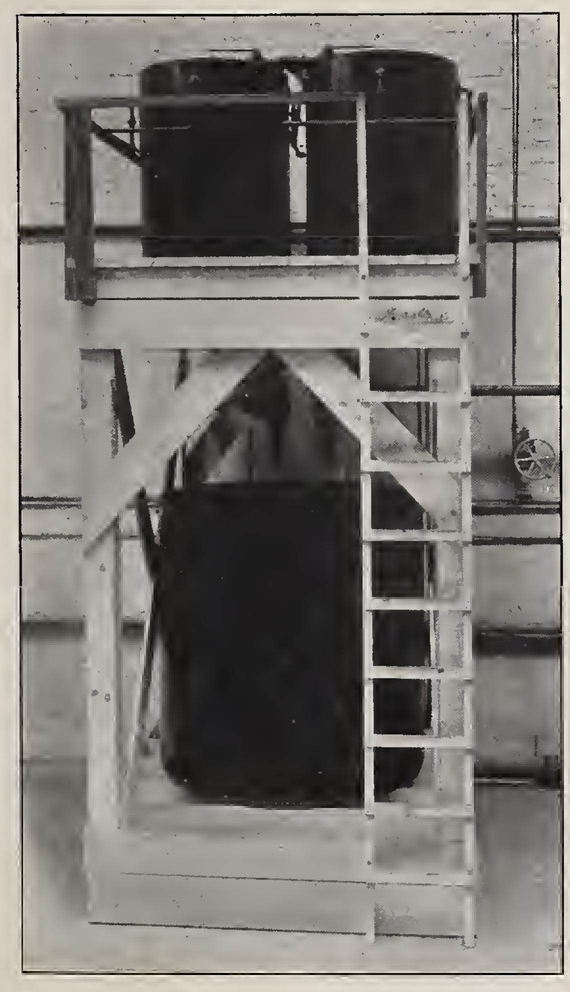
Steam is kept up day and night every day in the year, and everything has been arranged so as to operate the plant under all conditions with as great economy and safety as possible. The surplus circulating water from the condensers is pumped through the factory for various purposes where warm water may be used. All condensation in steam lines is pumped back into the boilers. All return water from the steam-heating system goes back to the boilers through the feed-water heater. The feed water is heated by exhaust steam from the various pumps.

The automatic stokers insure a reasonably complete combustion of fuel, as is evidenced by the absence of smoke from the stack; and the ashes are handled economically, as described previously. Two trolleys carrying chain hoists traverse the room from end to end on steel I-beams, for facilitating the moving of materials or machinery.

The layout of the piping system merits notice. A 20-inch header extends along the rear of the boilers in sections about 50 feet long. These sections are connected by 10-inch bends. At one end, in the rear of two batteries of boilers that were moved over from the old power station, a 12-inch header, which was used in the former location, has been utilized. This being at the end of the line is large enough. The header is carried on brackets extending out from the rear of the framework, and is directly supported on rollers and anchored at intervals between connecting bends.



GAUGES FOR ONE OF THE 1200-HP. UNITS

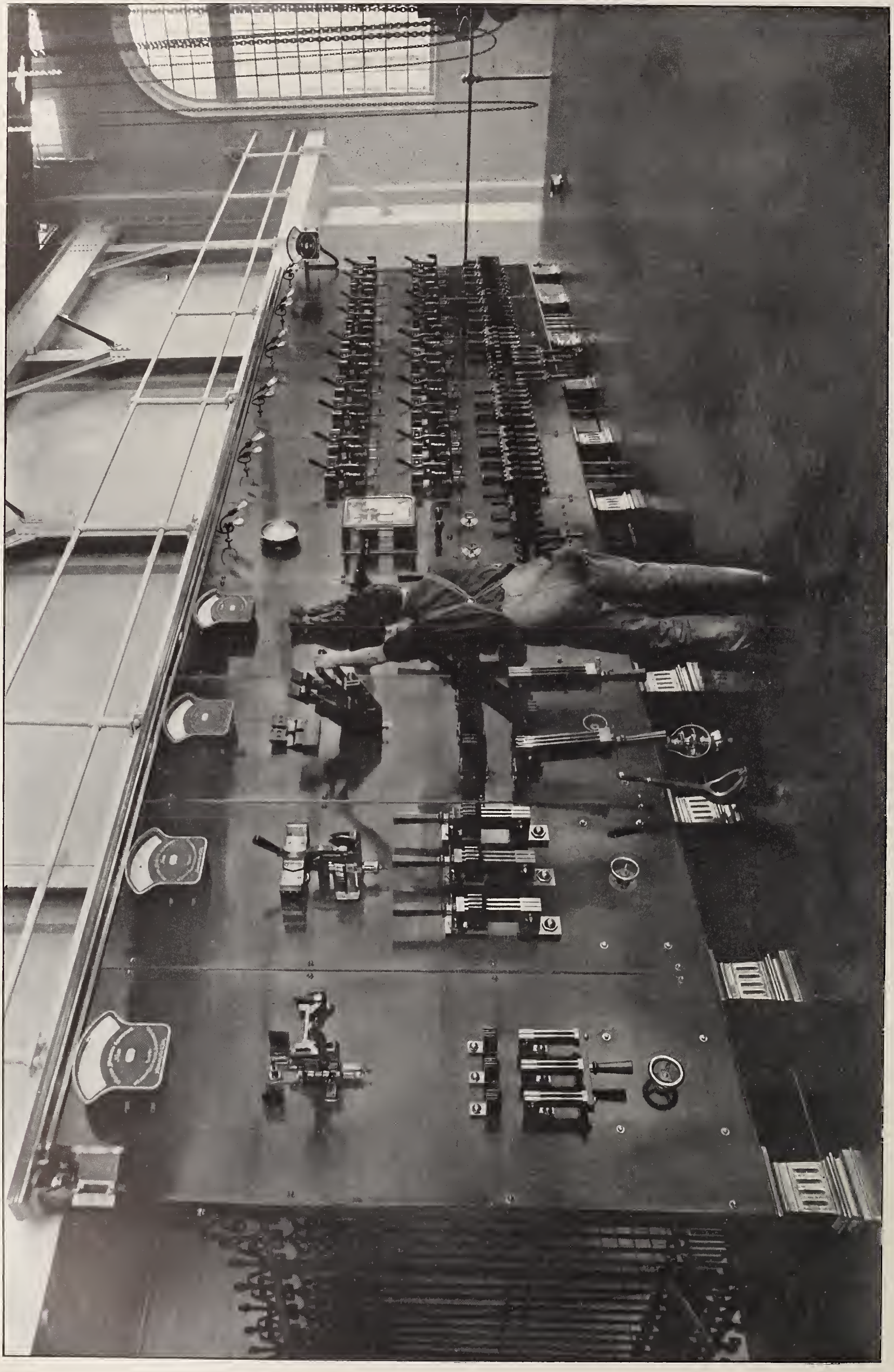


CALIBRATED TANKS IN THE BOILER ROOM FOR MEASURING THE FEED WATER

All boiler connections to header are made by means of bends. These are 8 inches in diameter and are made in the top of the header through flanged nozzles, the latter being riveted by hand to the header. The engine connections and the heating lines are also taken from the top of the header by similar connections.

Directly under each boiler connection a 4-inch line is taken from the main header and is connected into what is called the auxiliary header, which also runs the entire length of the boiler room at a lower elevation. This auxiliary header feeds the various pumps and condensers which are located along the rear of the boilers. Under every connection to this auxiliary header is a connection running to a drain line which extends the full length of the auxiliary header, and is, in turn, connected to a pump and receiver for returning condensed water direct to the boilers. It can be seen from the above description and by consulting the cross-section of the building which shows the piping, that it is practically impossible to get any water over into the engines.

Should any water come over from the boilers it would naturally go into the auxiliary header, where, in turn, it would be caught by the drain connections before it had a chance to get into the pumps. As a matter of fact, no trouble from water has ever been experienced in any portion of the steam-driven machinery. The pump and receiver, mentioned previously, serve to collect and return all drips from the piping system in addition to those from the auxiliary header, the steam separators and



A VIEW OF THE SWITCHBOARD

bleeders from the ends of the sections of header being manifolded into the same receiver. This latter contains a float which operates to admit steam to the little hot-water pump which pumps all collected water back into the boilers direct.

The feed-water lines are run in duplicate and so arranged that any or all pumps can work on either line. The disabling of one line would cause no interruption to the service.

The engine room is 183 feet long, 50 feet wide and 32 feet high, and is equipped with the following:—

One 300-H. P. Buckeye tandem-compound condensing engine, directly connected to a 225-KW. Siemens & Halske generator. Engine is 13 and 25 by 30 inches and runs at 150 revolutions per minute.

One 600-H. P. Buckeye tandem-compound condensing engine, directly connected to a 486-KW. General Electric Company generator. Engine is $18\frac{3}{4}$ and 36 by 33 inches and runs at 127 revolutions per minute.

Two 1200-H. P. Cooper-Corliss cross compound condensing engines, each directly connected to an 800-KW. General Electric generator. The engines are 26 and 54 by 48 inches and run at 80 revolutions per minute.

One 40-ton traveling crane with two 20-ton trolleys.

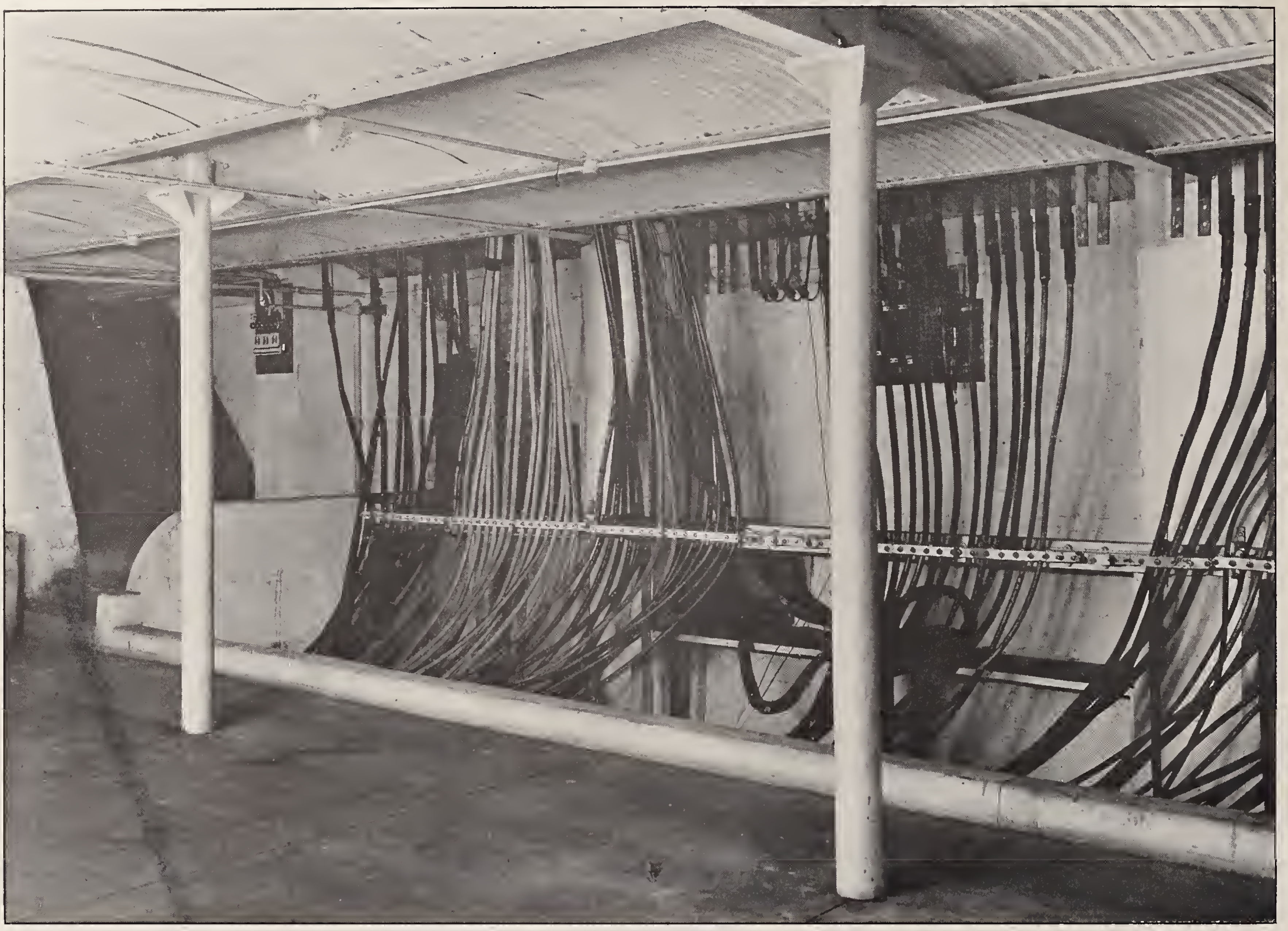
The aggregate rated engine horsepower is 3300, and the different generators are connected to the board so that any number of them may be used together. All engines are lubricated automatically by a gravity system, the oil being fed from a tank in the boiler room to every bearing of each engine. From the engines the oil passes through filters and is used again. The boiler room floor level, being so much below that of the engine room, permits all steam connection to and from the engines to be made below the floor, and no piping shows in the engine room.

A 2000-cubic foot air compressor is being at present installed in the space shown on the plan. This will be used to furnish compressed air to many factory departments where its use has been proved to be of great value in various manufacturing operations.

At the extreme west end of the engine room there is an enclosed driveway, by means of which new equipment may be hauled into the engine room and set up in either the boiler or engine room without exposing the room in cold or stormy weather. This arrangement will appeal to anyone who has experienced the annoyance and discomfort, if not actual danger, of getting new machinery into an operating station in winter weather. Here the loaded wagon or dray drives into the station, the doors are closed behind it,

IN THE BOILER ROOM. COAL CHUTES FROM OVERHEAD BUNKERS SUPPLY MURPHY MECHANICAL STOKERS

A CORNER IN THE WORKMEN'S DRESSING ROOM IN THE BASEMENT, SHOWING VENTILATED LOCKERS. SHOWER BATHS AND OTHER WASHING FACILITIES ARE IN A CONNECTING ROOM AT THE LEFT



FROM THE SWITCHBOARD THE CABLES ARE CARRIED THROUGH TUNNELS TO THE VARIOUS FACTORY BUILDINGS, AS SHOWN IN THE PLAN ON PAGE 404

and the work of unloading done by means of the crane, unhampered by exposure. (See page 401).

The switchboard is of black-enamel slate, consisting of ten panels, each 3 feet wide and 8 feet high. All light and power circuits are protected by circuit breakers and all switches and instruments are of copper. A recording wattmeter measures the electrical output of all generators. The back of the board is extremely simple and clean cut, no mixed-up connections or mess of wiring marring its appearance or complicating its arrangement.

On the chief engineer's desk a very convenient arrangement of gauges shows him at all times the pressure on his main steam header, on each of his heating lines, hot and cold water supply, and fire system. A recording steam gauge in the center of the set shows him the condition of his boiler room, and enables him at a glance to detect any irregularities that may have occurred at any hour of the twenty-four.

A visitors' gallery extending the entire length of the engine room along the south side affords a fine view of the engines in operation. From this platform a doorway through the wall gives access to a connecting platform in the boiler room. The latter extends across the east end of the boiler room above the smoke flue, and from this one looks over the tops of the boilers and steam piping and down on the pumps, condensers, and stokers on the floor 40 feet below. These platforms not only afford an excellent view of both engine and boiler rooms, but make it possible to accommodate a large number of visitors at a time without the disadvantage of having them on the floor where they might be very much in the way of the engineers.

The interior of the engine room has been finished to accord with the quality of the machinery which it encloses and presents a dignified and handsome appearance. The ceilings and sidewalls have been plastered and painted. Wood trim has been put in around all windows and doors. An enamel brick wainscot 9 feet in height extends around the entire room. The floor is polished maple. The brick is ivory white, ceilings and side walls cream coloured, and the woodwork white. Illumination is furnished from rows of electric lights on the bottom of each roof truss and from clusters under the gallery and side brackets around the walls. This provides well-distributed light all over the room.

The basement under the engine room contains the men's lavatories and locker rooms, and various cupboards for storing emergency materials of all kinds that may be needed for repairs.

All of the electric cables from the generators to the switchboard have been run in tile ducts back of the foundations and under the floor to the switchboard. The numerous light and power circuits from this board to the various buildings are now run through similar ducts under the street, the basement, and tunnel floors, to the points where they ascend through cable shafts to the various departments. This arrangement removes from view, and from liability to injury, the mass of large cables that would otherwise have to run

through the factory basements and inter-communicating tunnels.

Extensive alterations and improvements have been made on the coal terrace, the old driveway to the terrace along the west end of the plant has been abandoned, and the grade of the alley south of the plant has been changed so as to afford an approach on a gradual incline from both the east and west. In order not to have to tear out any work, should railroad facilities for handling coal be afforded in the future, provision was made for so strengthening the construction over the coal bunkers as to make it possible to carry a loaded car of coal over the bunkers and dump it directly in place. This necessitated the installation of heavy box girders to carry the weight. The entire bunker space is enclosed along the south with a brick wall, conforming to the outside boiler room walls and having large doors opposite each boiler through which the coal is emptied. This enclosing of the coal bunkers removes the disadvantage that might be experienced in winter through the freezing of the coal. At the extreme east end of the bunkers the wall is omitted and a rolling steel shutter affords the means of protection when closed and a place to take in a car of coal when open.

Part of the regular equipment of the boiler room is a system of tanks by which an evaporative test for coal may be made on the boilers at any time. The contents of the two upper tanks are accurately calibrated and are arranged so that they may be emptied alternately into the lower tank. This lower tank may be connected with any feed-pump in the boiler room, and through an arrangement of the feed lines, may be connected to any one or more batteries or boilers.

The company makes a yearly contract for its coal, based on the results of evaporating tests. By means of these tanks the coal is checked up every thirty or sixty days, or at any other time when it is believed the coal is not up to standard.

THE CURVED STEAM HEADER CONNECTIONS IN THE BOILER ROOM

An Electro-Chronograph for Timing Automobile Races

According to "The Scientific American," a new electro-chronograph for timing races has been devised by D. Owen, lecturer in physics at the Birmingham Technical School, Birmingham, England. The apparatus comprises a revolving drum which rotates at a uniform speed. The surface of the drum is smoked, and on it presses a stylus attached to an electro-magnet which travels parallel to the axis of the drum as the latter revolves, thereby making an helical trace on the drum.

The electric circuit includes a target switch and a tape switch. The starting pistol is fired at the target on the target switch, thereby opening the circuit and lifting the stylus momentarily from the drum. When the tape is reached and broken, the same action takes place, and the number of revolutions of the drum between the two breaks is then read off.

The timing of the speed of the drum is made electrically under the actual conditions of the race by placing the electro-magnet of the chronograph in connection with a pendulum or clock, which is made to mark on the revolving drum at intervals of one second. A 10-second race can thus be timed with certainty to one-fiftieth of a second.

Telephones have been installed in the pews of the Munn Avenue Presbyterian Church in East Orange, N. J. The receivers are connected with a transmitter in the pulpit, and the pew occupant throws in a switch when it is desired to hear the sermon. This is one of many such installations in churches throughout the country.

A New Electrically Operated Transporter Bridge

Connecting Widnes and Runcorn, England

By E. OMMELANGE

A GENERAL VIEW OF THE BRIDGE

AN electric transporter bridge, constructed in England over the River Mersey between Widnes, in Lancashire, and Runcorn, in Cheshire, was recently opened for service. The structure is said to have cost about $630,000, a very much smaller amount than would have been required for any other kind of bridge.

The bridge itself is a handsome structure of the stiffened suspension type. A double steel tower of pleasing appearance has been built on a rock foundation on each side of the river. The summits of these towers are 200 feet above low-water level. Two huge steel cables, nearly 1 foot in diameter, form the 1000-foot span, being anchored to the rock beyond the towers. The cables pass over suitable saddles on rollers on the top of the towers, so that they can contract and expand without difficulty.

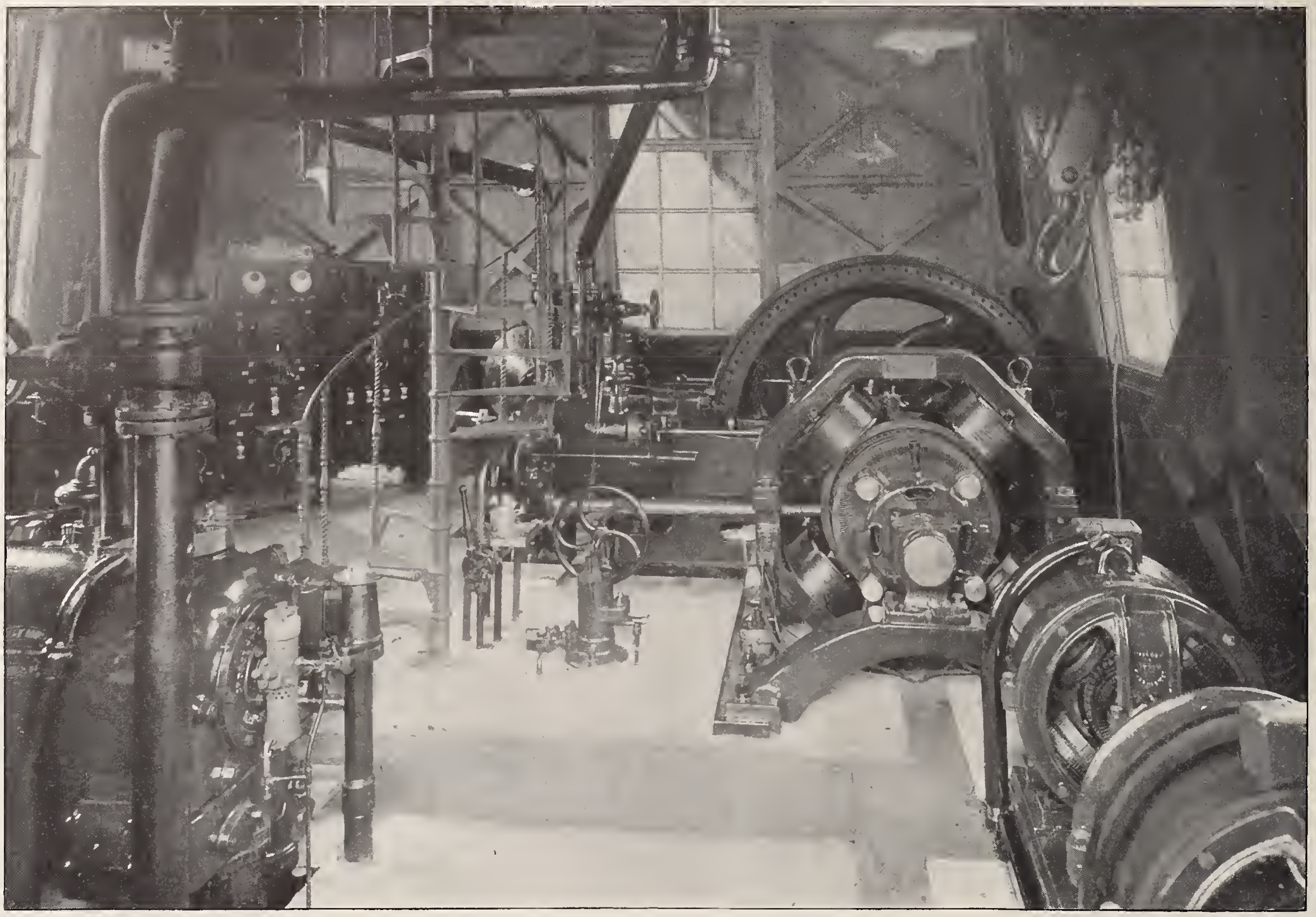
Each cable consists of nineteen steel strands, which, again, comprise 127 steel wires of 0.16-inch diameter. The two cables support the stiffened girders, which are 18 feet deep and are spaced 33 feet apart. These girders are braced together horizontally, and their lowest points are 82 feet above high-water level. An electrically driven trolley runs along this girder construction on rails. The trolley is about 77 feet long, and has sixteen running wheels on each side. A transporter car, 55 feet long by 24 feet wide, and large enough to carry simultaneously four two-horse farmer's wagons and 300 foot passengers, is hung from the trolley by a number of steel cables. The trip across occupies $2\frac{1}{2}$ minutes; the car passes about 12 feet above high water. On top of the car is the driver's cabin, from which a full view of the course may be obtained.

The engine house is in the tower on the Widnes side of the river, and contains the generating plant, which comprises two gas engines, each capable of developing 75 B. H. P. The gas is supplied from the Widnes town gas mains. Either of these engines is capable of providing the whole of the power necessary to work the bridge, one set being held in reserve.

Each engine is directly coupled to a multipolar dynamo built by Messrs. Mather & Platt, Ltd., of Manchester. These dynamos are each of 48-KW. capacity, and are capable of giving a continuous output of 90 amperes at 525 volts when running at 210 revolutions per minute. The engine room also contains a booster, consisting of

THE STORAGE BATTERY EQUIPMENT

THE SUSPENDED CARRIAGE MAKING A LANDING



THE ENGINES AND GENERATORS FOR SUPPLYING CURRENT TO THE TRANSPORTER BRIDGE OVER THE MERSEY

motor and generator directly coupled, and used for maintaining the voltage on the line, and equalizing the load on the generating dynamos.

A storage battery is placed in a room above the engine room, and consists of 245 cells having a capacity of 90 amperes for one hour. The engine room switchboard is arranged with three panels,—one for the dynamos, with the necessary main and regulating switches and measuring instruments; the second for the accumulator cells and booster; and the third panel for the feeding and lighting circuits.

From the switchboard the two main supply cables are led up the tower and across the main girders of the bridge, where they are attached to two overhead T-shaped conductors, from which the current is collected by trolley arms, and thence passes down to the controlling apparatus in the driver's cabin.

From the driver's cabin the wires are led straight up to the motors fixed on cross-girders connecting the pairs of trolleys, which run on each of the continuous main girders. The motors are of the Mather & Platt steel clad, entirely enclosed type, and are each capable of developing 35 B. H. P. when supplied with current at 500 volts.

The electric lighting equipment of the bridge also was supplied by Messrs. Mather & Platt. It consists of five arc lamps in each of the four lanterns at the summits of the towers, incandescent lamps in standards at the approaches on both sides of the river, and the necessary lights on the car itself, and in the waiting rooms and offices on the landings.

Electric Motors for Refrigerating Machinery

INTERESTING figures regarding the operation of small refrigerating machines by electric motors, were presented by G. W. Goddard in a paper before the recent Lake Champlain meeting of the Association of Edison Illuminating Companies. Mr. Goddard made a special study of small refrigerating machinery and its suitability for operation by motors and has discovered a large field for development in this direction. While artificial refrigeration has been extensively used in big hotels, apartment houses and on shipboard, it has a promising future for dairies, markets, grocery stores, saloons, drug stores and residences, both on account of the simplification of the power problem rendered by the electric motor drive and the removal of the inevitable trouble of handling ice in ordinary refrigeration systems.

A drug store installation was mentioned by Mr. Goddard in which refrigeration was required for three large soda fountains. The former conditions involved here were the usual ones of bringing ice into the store once or twice a day, breaking and placing it in the fountain at the top, resting on coiled $\frac{3}{8}$-inch block tin pipes, through which flows the beverage from cylinders in the basement to the soda fountain spigots. The soda water should be as near 32 degrees F. as possible, but it rarely can be maintained at a temperature below 40 to 45 degrees, by reason of improper insulation due to the door in the top of the fountain, warm air about the cylinders and the gradual rise of temperature as the atmospheric temperature rises and the bulk of ice falls. The refrigeration system installed was what may be called sweet

water circulating in the basement with a 7-H. P. direct-current motor driving a three-ton refrigerating machine, which expands directly into an insulated tank filled with sweet water, the suction coil returning directly to the machine. From this tank a coil runs to one of the three fountains on the floor above, where it manifolds in the bottled goods compartment and so continues to the two others, where, at the third, it rises and empties into the upper compartment, submerging the beverage coils and overflowing to the second fountain, and from there to the first, from which it returns to the tank, the circulation of the water being effected by a small rotary pump driven by a 1-H. P. motor. There is an additional chilled water circulation to a cold storage room in the basement in which the temperature is maintained at 40 to 45 degrees F. The plan of operation is to run the machine for a sufficient time to make enough ice on and about the expansion coils in the water tank with consequent low temperature in the fountain and cold storage room during operative hours of the machine to maintain the desired temperature until the next day.

The advantages of this plant are obvious, prominent among which are avoidance of ice deliveries with the attending slop and inconvenience, the time necessary to get the ice in condition and in place, constant temperature of 33 degrees as compared with 40 to 45 degrees with ice, securing dry air refrigeration in lower compartments of fountain, etc. The service rendered is equivalent to an ice consumption representing a cost of $820.86, to which should be charged the time of two employees of the place for two hours each morning throughout the year, amounting to $249.60, making the aggregate amount chargeable to refrigeration $1,070.46. Since the installation of the refrigeration plant there has been added a cold storage room of 724 cubic feet capacity, which would require half a ton of ice to maintain it at desired temperature, representing additional ice charge of $468, making the total cost chargeable to refrigeration of $1,538.46. The account chargeable to the electrically driven refrigerating plant to furnish refrigeration for the above named units is as follows:—Power for one year (based on average of eleven months), $579; interest 5 per cent. (on entire refrigeration plant, $2,100), $105; water for condensing purposes, $9; depreciation and repairs, at 10 per cent., $210; oil, waste, etc., $50; total, $953; difference in favour of electrically driven machine, $585.46.

A residence installation of interest was referred to in Mr. Goddard's paper which furnished refrigeration for a large three-compartment refrigerator 10 feet wide by 7 feet by 2 feet deep, usually full of varied food products. A galvanized iron tank 4 inches in depth by 5 feet high by 7 feet in length containing expansion coils submerged in a brine solution, was placed at the back and inside of the refrigerator with expansion coils connecting with a 500-pound refrigerating machine, located in the basement and driven by a 1-H. P. alternating-current motor. The entire outfit cost $502, installed.

A test of an equipment installed in large grocery store was described by Mr. Goddard. The plant embraces a 200-pound machine, driven by a $\frac{1}{2}$-H. P. direct-current motor, the entire machine equipment being enclosed in one end of the refrigerator, which measured over all 7 by 6 by 2 feet.

The tests extended from October 5 to November 2, 1904, inclusive, operating during the day from $5\frac{1}{2}$ to $12\frac{1}{2}$ hours, the average being 7.6 hours per day. The current consumption was from 1700 to 4600 watt hours per day, the average being 3675, the total consumption for the twenty-five days being 81.9-KW. hours.

The cost at 10 cents per kilowatt was $8.19, or $0.3276 per day. Taking the average daily watt hour consumption as a constant per annum, the cost for power per annum should not exceed $102.21, while, as a matter of fact, the meter readings showed the actual use of current to amount to a considerably lower figure than the above.

The price of the installation, exclusive of the motor and wiring, was $350, there having been no cost for repairs or additional charge for condensing water, the water being (for refrigeration-machine service) $3 per ton of refrigeration per year. The former amount of ice used to effect refrigeration in the same sized refrigerator was 200 pounds per day, the rate for which was 30 cents per 100 pounds, making the total cost of ice for the year $817.20.

From the foregoing it will be evident that the cost of operating the small refrigeration machine by electrical power at current rates compares very favourably with that of ice refrigeration, while the saving in labour is an important factor. The amount of attention and repairs for good apparatus is reported to be an unimportant quantity.

Standardization of the Third Rail

FROM an inspection of the designs for the support and protection of the third rail to be used respectively by the New York Central & Hudson River Railroad and the Long Island Railroad in the vicinity of New York City, "The Railway Age" draws the conclusion that the effort to standardize the location of these rails has been abandoned.

The lateral distance from the gauge line of the track rail to the center of the conductor rail is 29 inches for the New York Central, and $27\frac{1}{2}$ inches for the Pennsylvania's Long Island line. The vertical distance from the top of the track rail to the central surface of the conductor is $2\frac{3}{4}$ inches on the former line, and $3\frac{1}{2}$ inches on the latter. Apart from these wide differences of location, the designs for the protection of the third rails on the two lines are radically different. The New York Central rail is suspended from a high cast-iron goose-neck bracket, and the contact is on the lower surface of a bull-head rail, while the design for the Long Island rail shows a short column, with a T-rail directly above it, and the contact is necessarily on the upper surface.

In general, the design of the former is simple and straightforward, requiring comparatively few pieces, the section showing only four separate pieces of wood and two bolts for securing them, while the latter has six pieces of wood and six bolts at each bracket. The first cost and cost of maintenance must be greater with the Long Island design, and it does not appear to have any element of improvement over that of the New York Central.

The German Government is building a wireless telegraph station at Norddeich. It is expected to cover a circuit of not less than 932 miles, including Switzerland, France, Great Britain, Denmark, the larger part of Italy, Sweden and Norway, and parts of Spain, the Balkan peninsula and Russia.

Of petroleum and the drilling of oil wells there seems to be no end in this country. The production of last year was greater than that of any previous year. The total output of crude petroleum in the United States in 1904 was 117,063,421 barrels. The total value of all the petroleum marketed in the United States in 1904 was $101,170,466. The gain over the production of 1903 was 16,602,084 barrels in quantity and $6,476,416 in value.

Telephone Traffic

By ARTHUR VAUGHAN ABBOTT, C. E.

ACCORDING to a somewhat homely proverb, "Familiarity breeds contempt," but a more graceful and perhaps more truthful paraphrase is, "familiarity breeds carelessness," for there are many things with which daily use so familiarizes the user as to engender indifference.

Take, for example, the telephone. If a generation ago it had been predicted that a little semi-portable instrument could be supplied whereby, at pleasure, conversation with any desired correspondent between most cities in this country could be held, the prediction would have been laughed to scorn. To-day this feat is an accomplished fact, and a talk between New York and Chicago is regarded with no more astonishment than a colloquy between adjoining rooms. We are so accustomed to pick up a telephone and converse with any one, anywhere, that we have become almost oblivious to the train of sequences necessary to place parties in speaking relations with one another, and the complexity of the service which must be rendered.

To begin with, each correspondent must possess the necessary instruments,—transmitter and receiver,—with which to talk and hear. The telephone receiver is one of the most delicate instruments known to modern science. Its sensitiveness is so great as to cause an ingenious statistician to calculate that if the energy developed by dropping a receiver 1 foot could be converted into electricity and applied continuously to it, an audible sound would be produced lasting 240,000 years. Yet electricians have so perfected the construction of telephonic apparatus that even in the hands of the most careless there is little fear of derangement.

Next, the premises of each one who desires telephone service must be connected to a central office where parties can be interconnected at will when they desire to talk. This necessitates a large and complicated network of wire, literally covering every city, each conductor carefully insulated from every other and from all other objects. Finally, at the central office a switchboard is necessary to which the lines from the surrounding neighbourhood converge. This switchboard must contain the necessary apparatus whereby any subscriber to the exchange can signal an attendant, and designate to this operator the party with whom conversation is desired. There must be apparatus whereby the operator can connect together in talking relation any pair of lines, and ascertain when conversation is completed in order to set the lines free for other use.

For a quarter of a century inventors have been steadily devising means whereby the subscriber may be served more quickly, more accurately and more cheaply. As a result, a large modern telephone office appears something as in Fig. 2. The switchboard is a horseshoe-shaped structure arranged around the circumference of a large room, and is divided into sections, each containing a group of three operators. At the bottom of the vertical panels which form the rear of the switchboard, as seen in Fig. 2, and in front of each operator, there are a number of spring switches, called "jacks." One subscriber's line is attached to each jack. Directly under each of these jacks there is a small incandescent lamp. When any subscriber removes his receiver from the hook on which it hangs, the hook springs upward and closes a contact.

At the central office a battery is attached to all the lines. When the hook-switch contact closes, electricity from the battery passes over the line, and in so doing actuates a relay whose armature closes a battery circuit, including the little lamp referred to, and illumines it. Thus the act of removing the receiver, signals the operator and automatically tells her, not only that a subscriber is calling, but which one is signalling.

On a horizontal shelf in front of the operator there are a number of pairs of brass plugs which will fit into the spring jacks. The plugs of each pair are connected by a flexible cord which, like a lamp cord, contains two flexible wire conductors. When an operator sees a lamp flash she picks up a plug and inserts it into the jack next the lamp. When the plug enters the jack it automatically lifts the springs, extinguishing the lamp, and connects the subscriber's line to the conductors in the cord. Simultaneously the operator touches a button or key in the shelf in front of the cord, which connects the telephone on her ear to the line, and the subscriber hears the familiar cry, "Number, please."

In response, he tells the operator the number of the party he desires to converse with. Then the operator takes the companion plug and finds in the vertical panel in front of her a jack bearing the number called for;

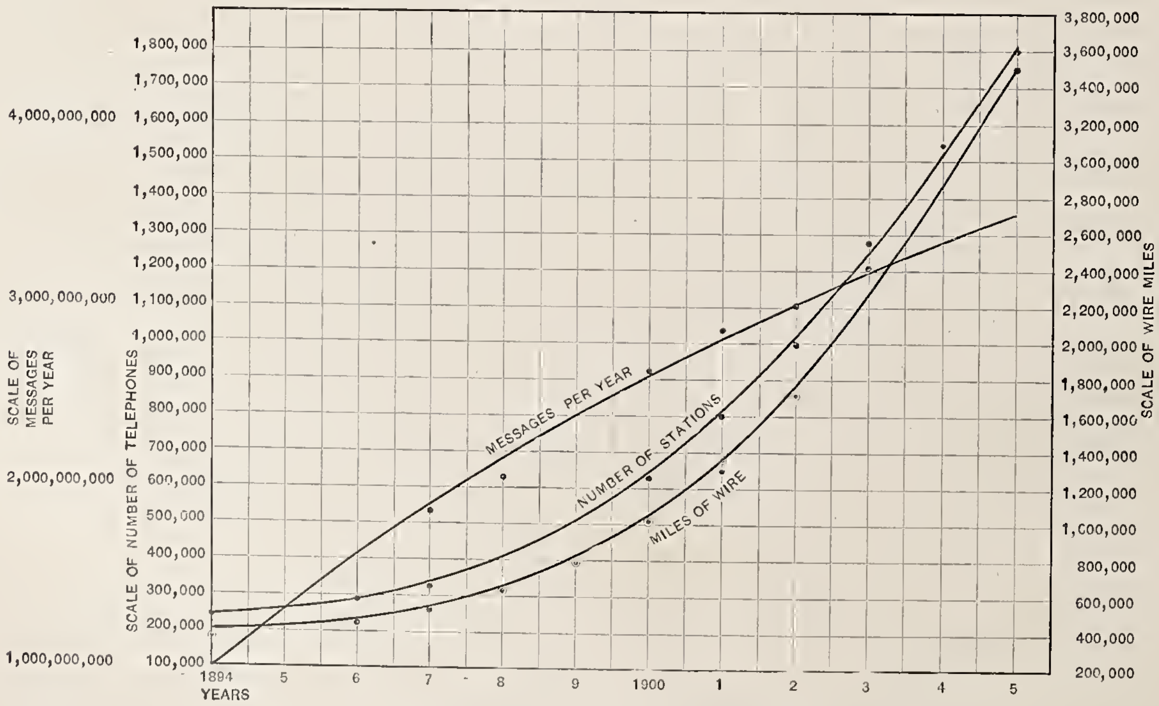


FIG. 1.—BELL TELEPHONE PROGRESS SINCE 1894

FIG. 2.—A MODERN TELEPHONE EXCHANGE

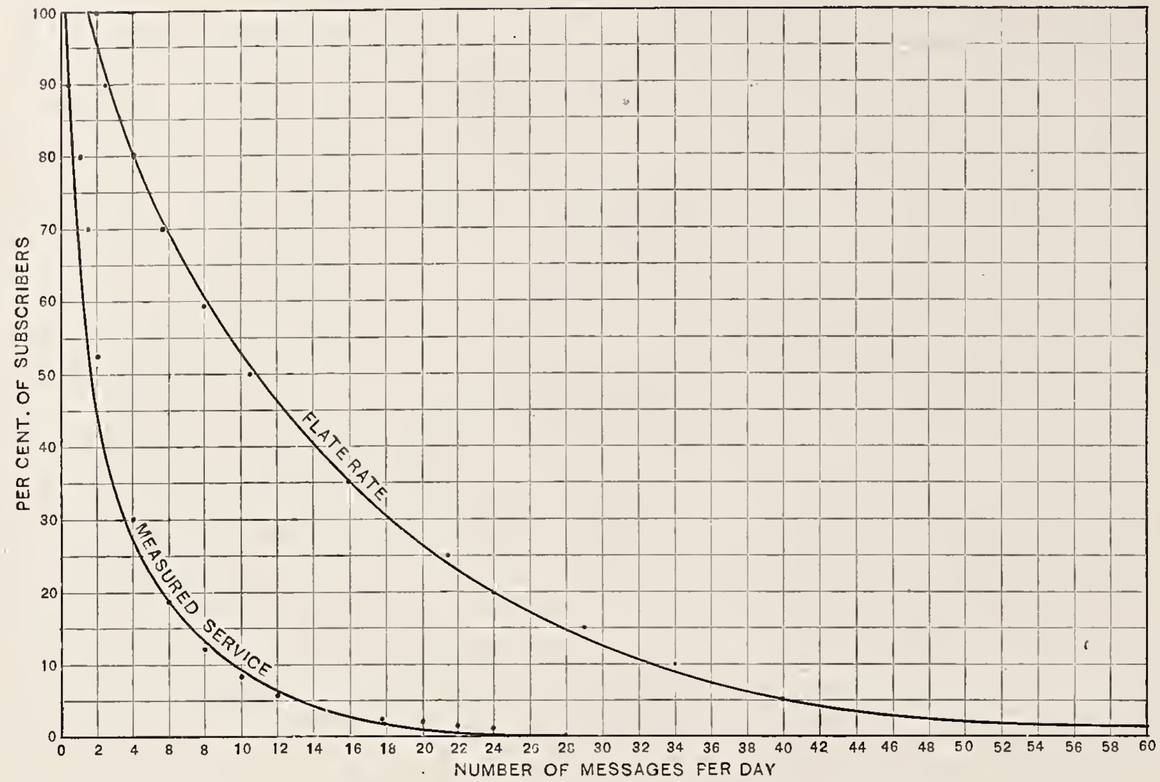


FIG. 3.—DIAGRAM ILLUSTRATING PROBABLE USE OF TELEPHONE

this jack is connected to the line of the called party. She touches the tip of the plug to the jack. If this subscriber is talking with anyone else, the operator will hear a sharp click in her receiver, but if the line be disengaged the receiver remains silent; then the operator inserts the plug, presses a second button, which automatically rings the bell of the called subscriber.

In the shelf there is a pair of little lamps for each pair of cords. Relays are arranged to connect one of these lamps with the line of the calling party and the other with that of the called party in such a manner that when either one replaces the receiver the proper lamp lights. So the operator knows by the illumination of these lamps when conversation is completed and when to remove the plugs.

While, as here described, the process of making a telephone call seems complicated, the switchboard has been so refined by the efforts of many inventors, and by training operators have become so proficient, that it is usual to have a call answered by the operator within three seconds after the receiver is lifted, and if the called party replies promptly, conversation begins within ten seconds.

When the speed and facility of intercourse with distant parties, which the telephone affords, are considered, the secret of its remarkable spread is revealed, though indeed few are aware how rapid the growth has been, or how enormous the business is which the telephone industry transacts. Table I, extracted from the United States Census, gives an idea of this aspect of telephony at the close of 1902.

TABLE I

Number of systems	4,151
Miles of wire	4,850,486
Number of subscribers	2,178,366
Stations or telephones of all kinds	2,315,297
Number of public exchanges	10,361
Messages or talks during year, total number	5,070,554,553
Local	4,949,849,709
Long distance and toll	120,704,844
Salaried officials, clerks, etc.:—	
Number	14,124
Salaries	$9,885,886
Wage-earners:—	
Average number	64,628
Wages	$26,369,735
Capital stock and bonds outstanding, par value	$348,031,058
Total revenue	$86,825,536
Operating expenses and fixed charges except interest on bonds	$61,652,823
Interest on bonds	$3,511,948
Dividends paid	$14,982,719
Net surplus	$6,678,046

For some years past the telephonic field has been divided between a consolidation of interests under the leadership of the American Telephone & Telegraph Company, usually for brevity called the Bell companies, and the so-called Independent organizations. Owing to the patent situation, there was no development of Independent companies prior to 1894.

In 1902 the census shows the field divided between the Bell and the Independent as per Table II. In other words, within eight years the Independents had installed a million telephones, which handled two billion messages per annum over one and one-half million miles of wire.

The Bell interests make annual reports, the Independents do not; hence it is easy to trace the growth of the former and difficult that of the latter. Fig. 1 gives a graphical history of the Bell progress since 1894. There are three curves, one showing the number of telephones or stations, another the miles of wire, and the third the traffic in messages per annum. Along the bottom of the sheet are recorded the years, and on the left are two scales, one showing the messages per year, and the other the number of telephones, while on the right-hand side there is a scale showing the number of wire miles. It is curious to note that the quantity of wire and the number of stations keep close pace with one another, though of late, owing to the introduction of party lines, the wire per telephone is decreasing. These curves are convex to the axis of time, the least rate of increase occurring between 1894 and 1897, while the greatest rate of growth is between 1903 and 1905, notwithstanding the competition offered by the Independent companies.

The message curve is concave to the axis of time, showing that the traffic is increasing less rapidly than the traffic facilities. The reason is not far to seek. Naturally, large business houses are the first telephonic customers, while residences are the last to take service. A single business telephone has been known to originate 125 to 150 calls per day. The average daily calls from the busiest commercial houses range from thirty to forty per telephone. From residences, on the other hand, the call rate drops to two or three. Evidently, therefore, as telephonic facilities are extended to the small user, the average message rate will decrease and cause the message curve to assume the shape given in the diagram.

The curves in Fig. 3 illustrate the probable use of the telephone. Two lines are shown, one applicable to flat-rate service and the other to measured service. The left-hand scale shows the percentage of the number of subscribers; the bottom scale the number of calls per day. An example will illustrate the use of the diagram. From 60 on the left-hand

TABLE II.

	Total	Bell	Independent
Number of systems	4,151	44	4,107
Miles of wire	4,850,486	3,387,924	1,462,562
Number of subscribers	2,178,366	1,222,327	956,039
Stations or telephones of all kinds	2,315,297	1,317,178	998,119
Number of public exchanges	10,361	3,753	6,608
Messages or talks during year, total number	5,070,554,553	3,074,530,060	1,996,024,493
Local exchanges	4.949,849,709	2,998,344,933	1,951,504,776
Long-distance and toll	120,704,844	76,185,127	44,519,717
Salaried officials, clerks, etc.:—			
Number	14,124	10,341	3,783
Salaries	$9,885,886	$7,848,551	$2,037,335
Wage-earners:—			
Average number	64,628	46,064	18,564
Wages	$26,369,735	$21,026,257	$5,343.478

TABLE III.

State and Territory	Stations or Telephones of all Kinds	Messages or Talks During Year	Estimated Population	Average Population per Telephone	Average Number of Messages per Capita	Average Number of Messages or Talks per phone per Year
United States	2,315,297	5,070,554,553	78,576,436	34	65	2,190
Alabama	14,077	46,158,943	1,891,755	134	24	3,279
Arizona	3,259	5,072,727	129,869	40	39	1,557
Arkansas	16,892	36,716,883	1,347,934	80	27	2,174
California	106,574	178,284,400	1,537,837	14	116	1,673
Colorado	24,533	60,258,533	559,715	23	108	2,456
Connecticut	22,494	35,933,102	941,184	42	38	1,597
Delaware	4,293	8,962,892	187,461	44	48	2,088
Florida	8,216	18,906,002	554,104	67	34	2,301
Georgia	25,490	96,192,066	2,298,713	90	42	3,774
Idaho	3,862	6,451,762	176,416	46	37	1,671
Illinois	211,187	541,161,932	5,019,628	24	108	2,562
Indian Territory	5,331	8,337,959	434,436	81	19	1,564
Indiana	132,489	294,657,565	2,581,575	19	114	2,224
Iowa	120,017	193,054,738	2,301,427	19	84	1,609
Kansas	40,972	58,699,143	1 452,217	35	40	1 433
Kentucky	46,266	143,101,564	2,202,804	48	65	3,093
Louisiana	17,509	68,083,915	1,434,033	82	47	3,888
Maine	14 045	21,923,915	700,072	50	31	1,561
Maryland*	32 090	62,019,081	1,505,558	47	41	1,933
Massachusetts	96,512	183,115,320	2,917,796	30	63	1,897
Michigan	93,961	237,695,112	2,480,764	26	96	2,530
Minnesota	62,039	113,124,262	1,822,106	29	62	1,823
Mississippi	15,069	60,414,961	1,603,604	106	38	4,009
Missouri	93,371	242,309,227	3,187,031	34	76	2,595
Montana	5,421	11,352,976	266,120	49	43	2,094
Nebraska	36,153	73,227,030	1,087,526	30	67	2,025
Nevada	1,165	1,409,134	41,331	35	34	1,210
New Hampshire	9,949	16,987,012	418,602	42	41	1,707
New Jersey	48,980	56,171,223	1,969,821	40	29	1,147
New Mexico	2,481	4,297,920	202,316	81	21	1,732
New York	246,015	360,098,123	7,533,011	31	48	1,464
North Carolina	16,252	36,485,398	1,948,984	120	19	2,245
North Dakota	6,762	14,106,733	344,778	51	41	2,086
Ohio	222,767	558,707,801	4,252,372	19	131	2,508
Oklahoma	10,385	23,329,668	463,312	45	50	2,246
Oregon	21,172	35,777,238	429,380	20	83	1,690
Pennsylvania	186,572	493,617,718	6,505,887	35	76	2,646
South Carolina	10,467	23,893,914	1,378,150	132	17	2,283
South Dakota	10,305	17,919,604	429,808	42	42	1,739
Tennessee	36,060	128,274,719	2,070,354	57	62	3,557
Texas	64,410	167,079,014	3,203,303	50	52	2,594
Utah	5,734	11,755,130	289,519	50	41	2,050
Vermont	12,112	19,075,847	345,885	29	55	1,575
Virginia	24,130	65,494,626	1,899,440	79	34	2,714
Washington	31,447	64,623,982	558,055	18	116	2,055
West Virginia	22,376	41,605,891	998,004	45	42	1,859
Wisconsin	61,145	101,594,728	2,127,974	35	48	1,662
All other States†	12,489	23,033,120	544,465	44	42	1,844

*Includes District of Columbia. †Includes Rhode Island and Wyoming.

scale follow a horizontal line to the curve headed "Flat Rate," thence to a vertical to the bottom scale, finding 8. This means that 60 per cent. of the flat-rate subscribers make more than eight calls per day, and 40 per cent. less than eight.

The statistics of the census shed an interesting light upon telephone traffic. The business in the different States and Territories is shown in Table III.

The State of Ohio was telephonically most loquacious, talking 131 times per capita per annum, while Indian Territory footed the list with nineteen talks per capita per annum. The telephonic facilities afforded in large cities are shown in a striking manner in Table IV. The city of New York heads the list with 93,000 instruments, which, since the compilation of the census, has grown to nearly 150,000. But in New York there were thirty-nine people to every telephone, while in San Francisco there were only nine, in Cleveland sixteen, and in Boston nineteen.

A telephone company sells transportation just as a railway company sells transportation. A railway plant consists in part of a track on which runs the locomotive, a train of cars loaded with passengers or merchandise collected from many sources. A telephone company provides tracks in the shape of wires to each subscriber, over which intelligence is hauled, not by a tangible locomotive, but by the more impalpable but equally real energy of an electric current, and it is folly for a telephone manager to be in ignorance of the capabilities of his operators and of the possibilities of his switchboard, trunk lines and other apparatus. A telephone exchange exists solely for the purpose of carrying intelligence from point to point, so it is a vender of traffic in absolutely the same sense as any other transportation company.

TABLE IV.

	Estimated Population	Number of Stations or Telephones	Average Population per Telephone
New York	3,623,160	93,301	39
Chicago	1,815,445	60,948	30
Philadelphia	1,343,043	46,393	29
St. Louis	599,932	19,228	31
Boston	583,376	30,202	19
Baltimore	523,861	15,181	35
Cleveland	403,032	24,809	16
Buffalo	371,731	12,385	30
San Francisco	351,540	38,031	9
Cincinnati	329,590	13,627	24
Milwaukee	304,965	10,765	28
Detroit	301,670	12,536	24
New Orleans	296,118	7,158	41
Washington	283,551	8,051	35

It is interesting to know something of the expense of transporting intelligence telephonically. Table V. exhibits cost statistics in the different States and Territories.

New York State pays most for its telephonic service, spending \$66.47 per telephone per annum, while Iowa spends least, showing \$16.35. Taking the average of the United States, the following is a summary of cost:—

Cost per message to subscriber	1.725 cents
Operating expense	1.125 "
Fixed charges	.165 "
Profit	.431 "

To the ordinary user of the telephone, who pays a dime per call at a public station, or is charged from 5 to 10 cents per message, working under a measured service contract, these figures may seem somewhat surprising. In viewing them it must be remembered that they are averages of the telephonic service all over this country, and include all flat-rate

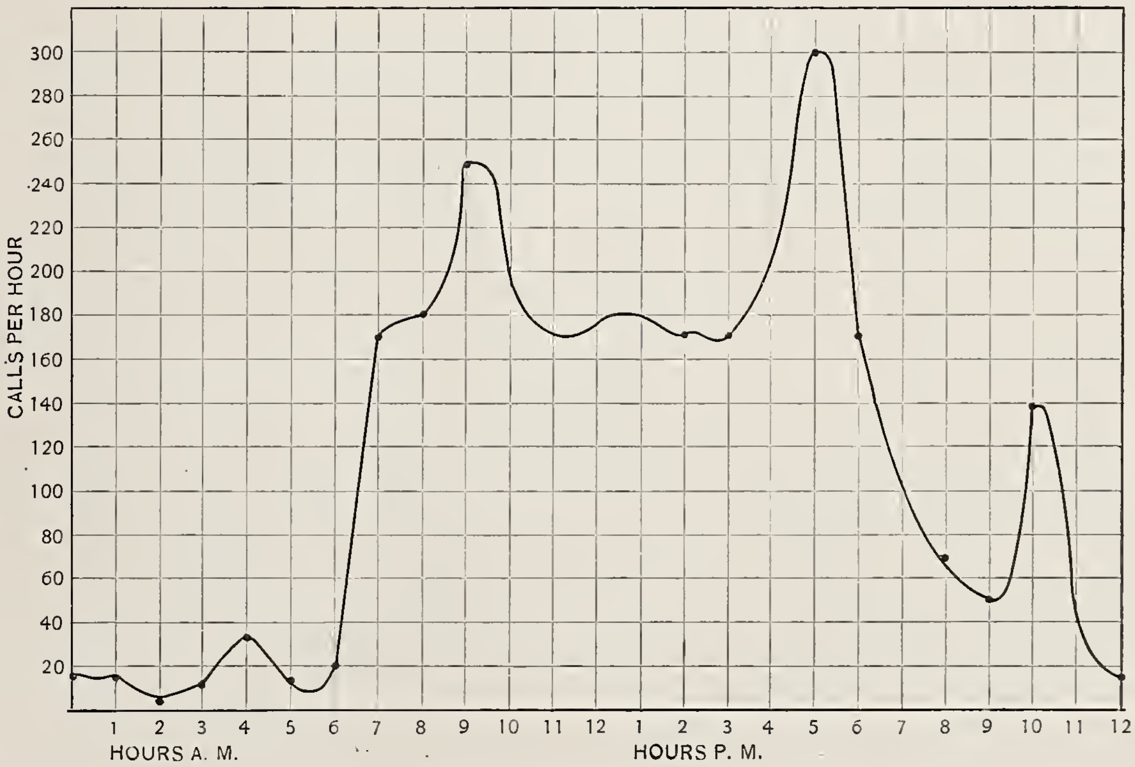


FIG. 4.—TELEPHONE LOAD LINE FOR AN EXCHANGE IN A MANUFACTURING TOWN

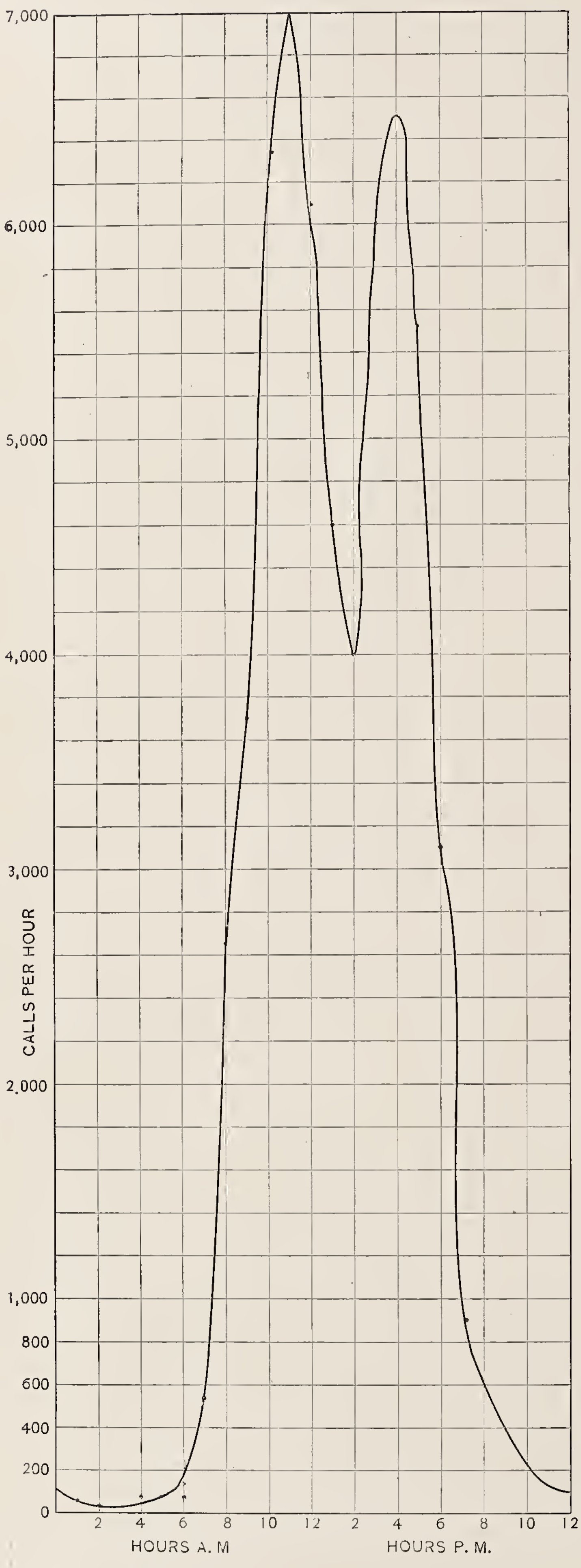


FIG. 5.—TELEPHONE LOAD LINE FOR AN EXCHANGE IN A LARGE CITY

service under which the subscriber uses his telephone at pleasure. Under a flat-rate tariff there is no incentive to economy in the use of the telephone by the subscriber and various members of his family, frequently his friends, and sometimes the whole neighbourhood, use his telephone without let or hindrance. Hence the traffic under flat-rate conditions becomes very great. When measured service is offered, the subscriber pays for each message; he consequently observes greater economy in the use of his telephone, and jealously guards the instrument from others who do not share in its annual cost.

It is interesting to compare the cost of telephone service with that of the Post Office service. The charge for an ordinary letter is 2 cents, but the average cost of transporting intelligence by mail would be considerably greater if the charges for special delivery letters, packages of greater weight than 1 ounce, registered letters, etc., were included in the average. The preceding telephone costs include the charges for toll and long-distance service, and hence the average charge of 1.7 cents per message embraces all special service, so it is evidently cheaper to telephone than it is to write.

Fconomy in telephoning is still further emphasized when it is remembered that for most letters an answer is needed, and hence the total cost of a completed communication is 4 cents or over, but each telephone message at its cost of 1.7 cents carries with it its own answer, and, moreover, most telephone messages consist of more words than are contained in an ordinary pair of letters. Roughly, therefore, it may be estimated that the cost of transmitting intelligence by telephone is about one-third that of the corresponding expense by mail.

The operating expense as has been shown is about 1.25 cents per message. This is approximately 65 per cent. of the cost to the subscriber. While the expense for telephone service includes many items, the chief one is that for operators at the switchboard who handle subscribers' calls, as already described.

Telephony is peculiar, in that it possesses no inertia, for when a subscriber calls he must be answered upon the instant. There is no known, and it may almost be said no conceivable, means whereby calls can be stored when an operator is busy, and be delivered at her leisure. Therefore, there must at all times be a sufficient force at the switchboard to handle the maximum number of calls which arrive at any time, without subjecting subscribers to unreasonable delay. So to provide adequate facilities and force, the telephone manager must know approximately not only how many times per day each subscriber will call, but when his messages are liable to arrive.

For this purpose, traffic records are made by counting the number of calls in a telephone exchange for each hour during a given twenty-four, and plotting the results so as to clearly present to the eye a picture of the day's business. Such curves are called load lines, specimens of which are exhibited in Figs. 4, 5 and 6 In each of the diagrams the horizontal scale shows the hours of the day, and the vertical scale the number of calls per hour; hence, each diagram portrays the rate at which business is received.

Fig. 5 is a diagram from a large city of about 1,500,000 inhabitants. Between midnight and 6 a. m., the load upon the switchboard was almost inappreciable. Starting with

TABLE V.

State or Territory	Average Number of Messages or Talks per Telephone per Year	Average per Telephone per Year			
		Gross Income	Operating Expenses	Fixed Charges	Net Income
United States	2,190	$37.50	$24.56	$3.58	$9.36
Alabama........	3,279	37.57	22.37	6.37	8.83
Arizona.........	1,557	35.13	21.44	1.95	11.74
Arkansas.......	2,174	33.45	21.80	1.87	9.78
California.......	1,673	38.39	30.02	2.17	6.20
Colorado........	2,456	46.36	31.23	1.41	13.72
Connecticut.....	1,597	59.05	39.45	3.70	15.90
Delaware.......	2,088	44.22	36.66	11.39	*3.83
Florida.........	2,301	25.82	16.65	5.38	3.79
Georgia.........	3,774	33.86	21.26	7.29	5.31
Idaho..........	1,671	46.16	34.79	3.02	8.35
Illinois.........	2,562	34.61	23.73	2.49	8.39
Indian Territory	1,564	30.79	17.55	1.17	12.07
Indiana.........	2,224	21.26	13.54	2.79	4.93
Iowa...........	1,609	16.35	10.53	1.15	4.67
Kansas.........	1,433	21.42	12.76	1.12	7.54
Kentucky.......	3,093	29.77	19.72	3.87	6.16
Louisiana.......	3,888	45.88	23.70	3.74	18.44
Maine..........	1,561	42.52	29.12	2.79	10.61
Maryland†......	1,933	47.28	34.47	7.31	5.50
Massachusetts...	1,897	63.49	43.58	6.26	13.65
Michigan.......	2,530	26.01	18.31	5.20	2.50
Minnesota......	1,823	30.30	18.30	2.96	9.04
Mississippi......	4,009	32.95	20.10	2.28	10.57
Missouri........	2,595	31.81	19.14	3.50	9.17
Montana........	2,094	56.26	39.43	2.34	14.49
Nebraska.......	2,025	30.63	22.10	1.07	7.46
Nevada.........	1,210	30.05	15.85	1.67	12.53
New Hampshire.	1,707	39.87	30.67	2.33	6.87
New Jersey.....	1,147	55.91	39.55	5.50	10.86
New Mexico....	1,732	21.94	12.98	0.52	8.44
New York......	1,464	66.47	39.79	4.66	22.02
North Carolina..	2,245	21.32	14.93	2.08	4.31
North Dakota...	2,086	34.81	20.20	2.06	12.55
Ohio...........	2,508	27.80	17.06	4.56	6.18
Oklahoma......	2,246	25.83	16.37	1.13	8.33
Oregon.........	1,690	31.13	21.34	0.85	8.94
Pennsylvania....	2,646	43.33	28.91	4.94	9.48
South Carolina..	2,283	27.23	17.86	4.41	4.96
South Dakota...	1,739	27.86	15.84	1.11	10.91
Tennessee.......	3,557	34.73	24.47	2.94	7.32
Texas..........	2,594	38.60	24.60	3.41	10.59
Utah...........	2,050	51.26	37.59	2.33	11.34
Vermont........	1,575	26.62	19.33	1.52	5.77
Virginia........	2,714	25.25	16.73	4.07	4.45
Washington.....	2,055	31.48	24.77	1.81	4.90
West Virginia...	1,859	22.69	15.21	2.52	4.96
Wisconsin.......	1,662	26.16	16.17	2.12	7.87
All other States*g*.	1,844	69.31	43.46	1.98	23.87

* Deficit. † Includes District of Columbia. *g* Includes Rhode Island and Wyoming.

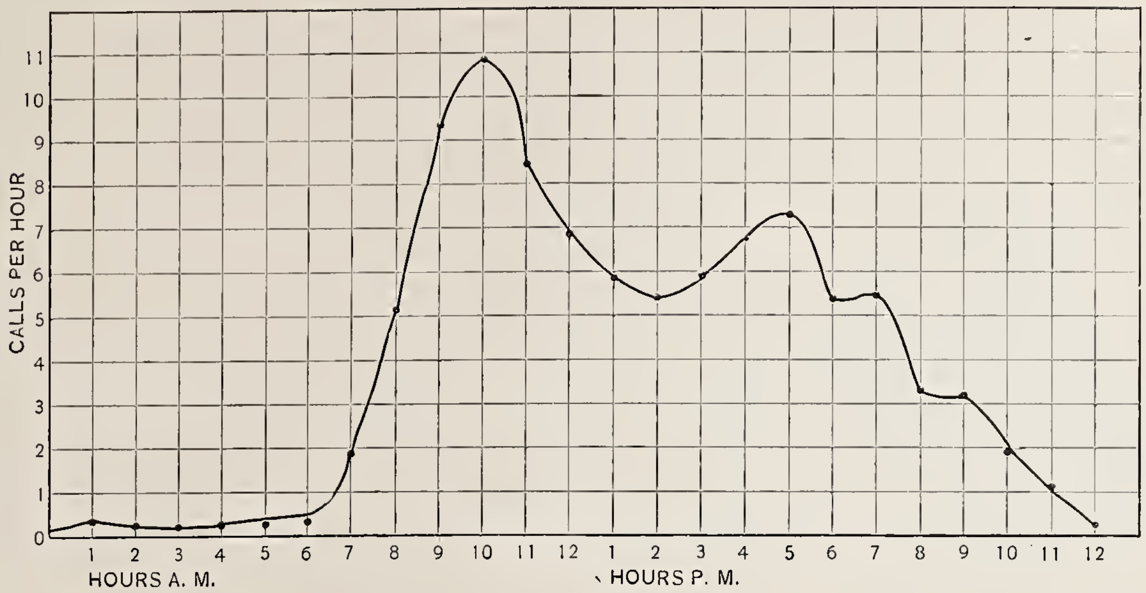


FIG. 6.—TELEPHONE LOAD LINE FOR AN EXCHANGE IN A SMALL TOWN

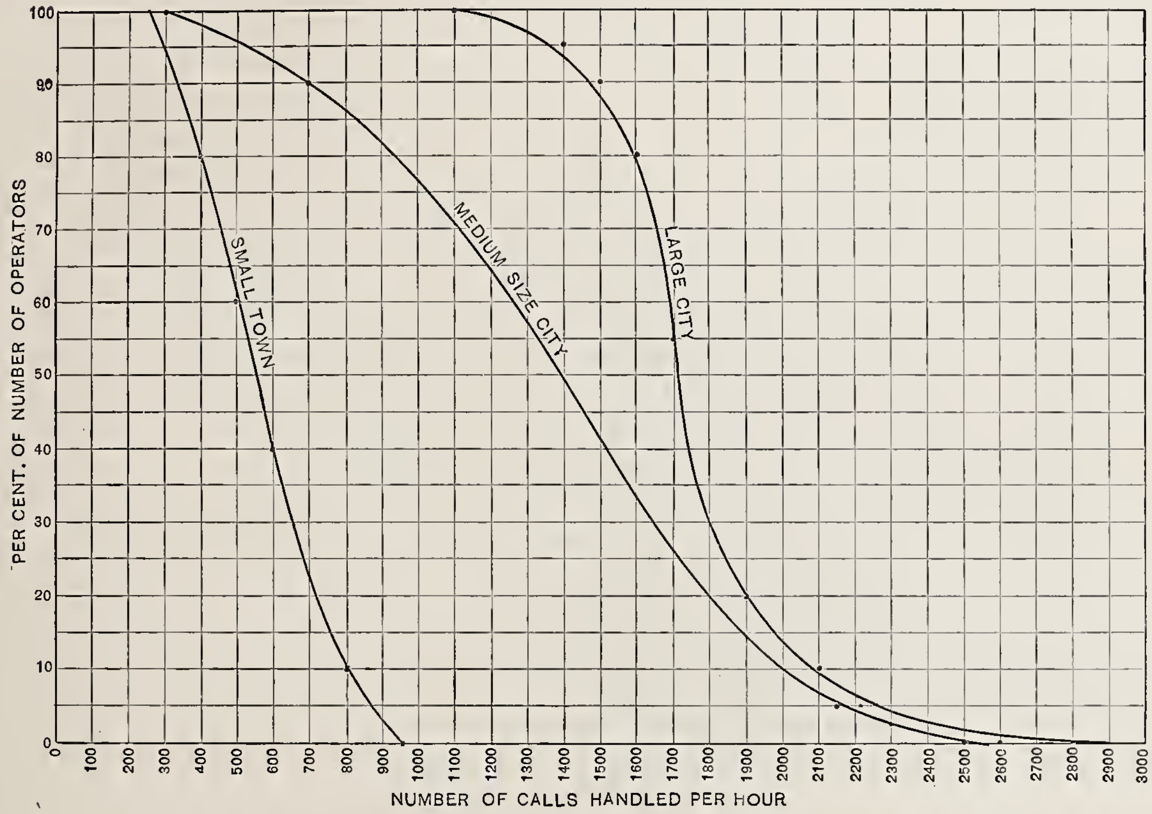


FIG. 7.—CURVES SHOWING THE RATE AT WHICH OPERATORS WORK

200 calls per hour at 6 a. m., there were 2500 at 8 a. m., 3700 at 9 a. m., and 7000 at 11 a. m. At 2 p. m. the rate had dropped to 4000, increasing to 6500 at 4 p. m., and dropping to 800 at 7 p. m. The most striking feature of such a curve is the rapid fluctuations in load to which the operators and the switchboard must respond. Such a load line reflects with accuracy the habits of the community in which the exchange is located. One perceives that the greatest amount of business is transacted at 11 a. m.; shortly after, the community goes to lunch, and at 2 p. m. is busily enjoying itself. At 4 p. m. there is another business rush, but one which does not equal the peak of the morning; while immediately thereafter the volume ebbs away to an insignificant evening load.

Fig. 4 is the load line from a manufacturing town in which large railway shops are located. This diagram indicates a much less concentrated rate of work, the business being spread over more hours in the day. Notice the peak at 4 a. m., due to the opening of the railway shops to furnish early trains. The business peak occurs at 9 a. m. instead of 11 a. m., while the noon recess lasts from 10.30 a. m. until 3 p. m. At 5 p. m. occurs the maximum load of the day, instead of in the morning. This is explained by the fact that in small towns, the line business is transacted chiefly in the afternoon. The peak at 10 p. m. indicates another activity due to the closing of the railway shops.

Fig. 6 shows the load line from an exchange in a small country village. The sharp fluctuations in the manufacturing town and in the city are absent, and traffic is still more uniformly distributed. The highest peak occurs at 10 a. m. with another lower one at 5 p. m.

By means of such diagrams it is possible for a telephone manager or engineer to form a fairly accurate estimate of the probable load which will be placed on a new exchange. But in order to proportion the size of the plant it is necessary to know the rate at which the operators can work. Some statistics, from experience bearing upon this, are shown in Fig. 7, the diagram containing curves showing the rate at which operators can handle calls in a large city, in a medium size city, and in a small town. The horizontal scale gives the number of calls handled per hour, and the left-hand scale the percentage of the number of operators. This diagram is to be read in the same way as Fig. 1. For example, taking 90 upon the left-hand scale, follow the horizontal line to the curve headed "Medium Size City," and thence a vertical line to the bottom of the sheet finding 700. This means that 90 per cent. of the operators in medium size cities handle almost 700 or more calls per hour, and 10 per cent. of them 700 or less calls. The other curves are read in a similar fashion.

These statistics indicate that some operators are capable of handling as many as 2800 calls per hour. They also indicate that there is a wide difference between the efficiencies of operators in large towns, medium size cities and villages. This difference in efficiency is partly due to the better apparatus supplied in a large city and to the operators being better trained, but particularly to the fact that in large places operators work under a much greater pressure and the subscribers respond more promptly, hence much more work can be accomplished.

It is hardly too much to say that the co-operation of the subscriber is one of the most vital factors in a swift and accurate telephone service, and that the much maligned "hello girl" is by no means solely responsible for error or confusion. Let the subscriber, therefore, lay aside a little of the carelessness of familiarity and see if a little pains on his part will not go far to improve a service that now too often receives a one-sided criticism.

On account of the subdivision of power which results from the use of many electric motors in a shop, there is less liability of interruption to manufacture, and, in case of overtime, it is not necessary to operate the whole works, with the usual heavy load of transmitting machinery.

Work of Niagara Power

By ALTON D. ADAMS

TEN years ago the first great electric plant began to operate at Niagara Falls. Now, more than one-half of the energy delivered by electric plants there is devoted to chemical industries, and fully 75 per cent. of their entire load is located within a radius of two miles.

Such loads as have been obtained by electric transmission to other cities and towns consist almost entirely of lamps and motors, but as much as 80 per cent. of the local consumption of current about the Falls is for electrochemical purposes. Electric heating with energy from Niagara, save in chemical processes and in one baking plant, is of slight importance thus far. From these facts it seems that the more important industries attracted to the Falls by the low power rates have been those engaged in electrochemical operators, and that energy transmitted from Niagara has been devoted almost entirely to work that otherwise would have been done by steam.

At the beginning of the present year, four electric stations were in operation about Niagara Falls, three on the New York side and one on the Ontario side of the Falls. Two of the stations on the New York side, with generator capacities of 37,500 and 41,250 KW., respectively, a total of 78,750 KW., are owned by the Niagara Falls Power Company, and the earlier of the two was started for commercial service an August 26, 1895. In the other electric generating plant on the New York side of the Falls, which is owned by the Niagara Falls Hydraulic Power & Manufacturing Company, the capacity is 22,680 KW., and regular operation began on October 13, 1896.

Across the Niagara River the only generating plant in operation at the beginning of 1905 was that of the International Railway Company, which has a capacity of 2700 KW., and does only railway work. In these four plants the total generator capacity is thus 104,130 KW., but only the plant of the Niagara Falls Hydraulic Power & Manufacturing Company was fully loaded at the beginning of the present year. On the railway plant the exact load cannot be stated, but as a 1500-KW. generator was installed in the latter half of 1904, the load was probably much below the capacity of 2700 KW.

For the two plants of the Niagara Falls Power Company the entire load was not far from 60,000 KW. This maximum load was made up of about 36,000 KW. at Niagara Falls, New York; 1600 KW. at Niagara Falls, Ontario; 2400 KW. at Tonawanda; 1200 KW. at Lockport; 750 KW. at Olcott, and 18,000 KW. at Buffalo. On the New York side of the Falls the load of 36,000 KW. was made up by some twenty-three customers located from 0.14 to 2.18 miles from the two generating stations. Nine of these twenty-three customers engaged in electrochemical industries had a combined load of 30,000 KW. out of the total of 36,000 KW. Six customers had the load of 1600 KW. on the Canadian side of the Falls, and of this total, 375 KW. were supplied to the local lighting company, and a like amount to the Niagara, St. Catharines & Toronto Railway. At Tonawanda, the International Railway Company took about 1100 of the 2400 KW. of total load, and the remainder was distributed for local lighting and industrial purposes by the Tonawanda Power Company. In Lockport, the demand of the International Railway Company amounted to 750 KW., and the remainder of the load was supplied by the distribution system of the Lockport Gas & Electric Light Company. The load of 750 KW. at Olcott was furnished by the International Railway Company.

In December, 1904, the maximum load at the terminal house of the Cataract Power & Conduit Company, in Buffalo, which distributes all of the Niagara power sold there, was substantially 18,000 KW. Of this total, the International Railway Company took about 5200 KW. for its street car service, and the Buffalo General Electric Company distributed 4500 KW. for lighting and power. The remainder of the 18,000 KW. was supplied to about seventy large consumers, mainly for the production of mechanical power, by the Cataract Power & Conduit Company.

At the two stations of the Niagara Falls Power Company, twenty-one generators of 78,750 KW. combined capacity deliver 2200-volt, 25-cycle, two-phase current, and the local distribution by this company on the New York side of the Falls is carried out with such current. For the cable that runs across the river to supply the Canadian customers of the Niagara Falls Power Company, the current is transformed to 11,000 volts, 25 cycles, three-phase, as these customers are located between 3 and 4 miles from the two generating stations.

On the transmission lines between the power stations of the Niagara Falls Power Company and the terminal station of the Cataract Power & Conduit Company, in Buffalo, one of which is 20 and the other 22 miles long, the pressure is 22,000 volts, the frequency 25 cycles, and the current three-phase. Between Niagara Falls and Buffalo, some 14 miles from the two generating stations, the 22,000-volt lines pass through North Tonawanda, and deliver energy at this voltage to the Tonawanda Power Company and to the International Railway Company. The former of these two companies distributes light and power to local consumers in the cities of Tonawanda and North Tonawanda. From North Tonawanda to Lockport, a branch of the 22,000-volt line carries energy for the Lockport Gas & Electric Light Company, which receives it at a point about 25 miles from the generating plants. From Lockport the 22,000-volt line goes on to the railway sub-station at Olcott, a distance of 39 miles from the generating stations of the Niagara Falls Power Company. The 22,000-volt line from North Tonawanda to Lockport and Olcott is owned by the International Railway Company.

From the 2200-volt, 25-cycle, two-phase supply of energy by the Niagara Falls Power Company, local consumers obtain both two and three-phase current of 25, 60 and 125 cycles per second; also direct current at a variety of voltages, by transformation and conversion. Transformers and converters for these purposes are located on the premises of consumers, and are owned by them.

Largest among the local con-

sumers on the lines of the Niagara Power Company are the Union Carbide Company, the manufacturers of calcium carbide, which have a load of nearly 12,000 KW. At the works of this company the capacity of transformers is about 16,000 KW., and there were in operation some fifty carbide furnaces, each taking 2000 amperes at 110 volts, or 220 KW., and also forty motors in sizes up to 200 H. P.

Next largest, perhaps, among the consumers of electric power supplied by the Niagara Falls Power Company are the Pittsburg Reduction Company, which have a load of about 6000 KW., and was the first user of the energy generated by the former company. Another large consumer of the 2200-volt, two-phase energy are the Castner Electrolytic Alkali Company, whose load amounts to more than 5000 KW. The Carborundum Company keep four transformers of 3750 KW. total capacity in operation 24 hours per day, delivering current at a variable pressure of 100 to 200 volts to electric furnaces in which carborundum is made by fusing sand with coke, at a temperature of approximately 7000 degrees F. Carborundum finds its most important application as a grinding material in the form of wheels, stones, cloth, and paper, and for furnace linings where great ability to resist heat is necessary. The Carborundum Company also manufacture pure silicon, which, it is said, can be made for 25 cents per pound.

Another important consumer of the 2200-volt, two-phase, 25-cycle current are the International Acheson Graphite Company, whose most important product is graphite made from anthracite coal. For this purpose the coal is placed in a long, narrow trough lined with a highly refractory material, and an electric current representing 750 KW. is passed from end to end of the trough. In the latter part of 1904 the graphite company were using 750 KW. for a single furnace, but additional furnaces to consume 1500 KW. each, were being erected.

Electric reduction of lead ore to pure lead is carried on 24 hours per day by the Electric Lead Reduction Company. For this work the equipment consists of two direct-current generators, each rated at 250 KW. and 110 volts, and driven by a 300-H. P., 2200-volt, two-phase induction motor. An abrasive material known as alundum,—an oxide of aluminium,—is made in electric furnaces by the Norton Emery Wheel Company, which consumes nearly 500 KW. of the 2200-volt, 25-cycle current of the Niagara Falls Power Company for the purpose. The alundum is taken to Worcester, Mass., and is there made into grinding wheels and stones.

One of the most interesting of the industrial plants at the Falls is that of the Natural Food Company, which uses some 1200 KW. in the manufacture of shredded wheat biscuit and triscuit from white wheat, obtained largely from the Genesee Valley. Perhaps the most notable feature of this plant is the electric ovens in which the triscuit are baked. There are four of these ovens, and each is supplied with 25-cycle current at 80 to 127 volts from a pair of 140-KW. transformers, that operate with 2200 volts at the primary. Eight of these transformers with a total capacity of 1120 KW. are used to heat the four electric ovens, which constitute, perhaps, the largest electric plant for baking food to be found anywhere. According to tests, approximately 3.6-KW. hours of energy are consumed by a pair of the transformers and an electric oven for each pound of the triscuit baked.

General electric supply to ordinary consumers in Niagara Falls, N. Y., is carried on by the Buffalo & Niagara Falls Electric Light & Power Company, which draw about 750 KW. from the 2200-volt, 25-cycle, two-phase lines of the Niagara Falls Power Company, and also distribute the output of a 700-KW. 2200-volt, single-phase generator that is operated by a turbine water-wheel in the station of the Niagara Falls Hydraulic Power & Manufacturing Company. Current from this machine is distributed to service transformers in its original form, but the 25-cycle, two-phase energy from the 2200-volt cables of the Niagara Falls Power Company is, in large part, converted to 125 cycles per second, both constant pressure and constant current, and to 500-volt direct current before it reaches the lamps and motors of consumers.

Across the river, in Niagara Falls, Ontario, the Niagara Electric Light Company, which distribute the local lighting load, receive 11,000-volt, three-phase, 25-cycle current, and use it by means of induction motors to the extent of about 400 KW. During the construction of the new generating stations on the Canadian side of the Falls, as much as 750 KW. have at times been taken from the 11,000-volt lines of the Niagara Falls Power Company to aid in the work by operating induction motors.

In notable contrast with the two stations of the Niagara Falls Power Company, the station of the Niagara Falls Hydraulic Power & Manufacturing Company contains only three alternators, with a combined capacity of 2700 KW. in its total equipment of thirty-one generators, rated collectively at 22,680 KW. One of these alternators, rated at 7000 KW., is operated for the local lighting company, as already noted. Each of the other two alternators is rated at 1000 KW., 11,000 volts, three-phase, and is devoted to the supply of light and mechanical power in large manufacturing plants in the city of Niagara Falls. The twenty-eight direct-current generators in this station thus have a total rating of 19,980 KW., and their voltages range from 125 to 550. One of the 550-volt generators rated at 560 KW., and also a boosting dynamo, supply current for the operation of the Niagara Gorge Railroad. The other two generators of this voltage operate stationary motors in a brewery and are also used for commercial service.

A 150-KW., 125-volt generator supplies exciting current for the magnets of the alternators. In the three alternators and four direct-current dynamos just named, there is a combined capacity of 3670 KW., and the other twenty-four generators in the station of the Hydraulic Power & Manufacturing Company have a total rating of 18,310 KW., at voltages of 135 to 325. These twenty-four generators are devoted to electrochemical work in three large industrial plants at the top of the cliff above that part of Niagara Gorge where the power station is located, and only a few hundred feet distant. The three plants that thus furnish more than 80 per cent. of the load on this station are those of the National Electrolytic Company, the Acker Process Company, and the Pittsburg Reduction Company.

For the work of the National Electrolytic Company there are three generators, with a combined capacity of 1950 KW. Each of two of these generators is rated at 875 KW., 5000 amperes, and 175 volts, and the third at 200 KW., 1481 amperes, and 135 volts. Energy from these generators goes up the face of the cliff above the power station in aluminium cables, and is used in the electrolytic production of chlorate of potash.

During twenty-four hours per day and seven days per week, three 1000-KW. generators deliver current for the production of caustic soda by the electrolytic decomposition of sodium chloride, also oxide and bi-

chloride of tin, which goes on in the works of the Acker Process Company, about 1600 feet from the power station in the Gorge. Each of these generators is rated at 3080 amperes and 325 volts, and their combined current of 9240 amperes is transmitted through large groups of aluminium conductors in underground trenches, after the top of the cliff is reached. This entire current of 9240 amperes passes through a single series of electrolytic furnaces with four anodes each, so that each anode carries about 2320 amperes; the current flows into a cathode of molten lead, which takes up the sodium liberated by the decomposition of the salt with which the lead comes in contact.

About 60 per cent. of the entire load of the Niagara Falls Hydraulic Power & Manufacturing Company is furnished by the works of the Pittsburg Reduction Company, where aluminium is produced. These works are at the top of the cliff above the generating station, and the circuits carrying their current extend vertically along the face of the cliff, and are made up of sixty copper conductors of 500,000 C. M. each, and 100 aluminium conductors of 1,000,000 C. M. each. Eighteen generators with a total capacity of 13,360 KW. supply the current for the Pittsburg Reduction Company. Six of these generators with a combined rating of 3360 KW. deliver 12,000 amperes of current at 280 volts, and the other twelve generators with a total rating of 10,000 KW. deliver 33,333 amperes at 300 volts.

In North Tonawanda, 14 miles from Niagara Falls, and close to the 22,000-volt line of the Niagara Falls Power Company, is the station of the Tonawanda Power Company, where some of the 22,000-volt, 25-cycle current from the Falls is transformed and converted to 2300 volts and 60 cycles, and also to constant alternating current, for the general supply of arc and incandescent lamps. For the operation of stationary motors, current of 4400 volts, two-phase, and 25 cycles is distributed from this station, where the capacity of transformers is 3000 KW. Nearly all of the energy distributed from this point is used for lighting or motive power. The largest consumer supplied is the Tonawanda Board & Paper Company, which have a load of 900 KW.

In the station of the Lockport Gas & Electric Light Company, the 22,000-volt, 25-cycle, three-phase current from the transmission line is transformed to 2200 volts, two-phase, for distribution to motors, and is both transformed and converted to direct current for public and private lighting.

At Buffalo, the 22,000-volt lines from Niagara Falls terminate in transformers of 20,250-KW. total capacity, that reduce the pressure to 11,000 volts, and the current is subsequently transformed and converted for distribution at 2200 volts, 25-cycle, three-phase, at 2400 volts, 60-cycle, two-phase, as 250 and 500 volts constant pressure direct current, and as 6.8-ampere constant current.

Of the 18,000 KW. transmitted from Niagara Falls to Buffalo at times of maximum load, some 8000 KW. are distributed among about seventy large consumers in the form of 2200-volt, three-phase, 25-cycle current, and much the greater part of this is used for motive power in industrial plants. Prominent among the industries thus supplied with energy for mechanical power are a variety of metal-working plants that range from steam pumps to car wheels in output, several grain elevators, foundries, flour and cereal mills, malt houses and breweries, weaving and belting mills, a shipyard, a tannery, and chemical factories.

Customers supplied with energy from the 2200-volt, 25-cycle, three-phase lines are using electric motors with an aggregate capacity of about 20,000 H. P., and to this may be added some 3000 H. P. of motor capacity supplied with direct current at 500 volts, from the sub-station of the Buffalo General Electric Company. In more than a dozen of the plants using the three-phase, 25-cycle current, the maximum load ranges from 200 to 1000 H. P., and the motor equipments in most of these plants are of even greater capacity.

For the operation of the large power equipments, which generally consist of induction motors, the 2200-volt, three-phase current is usually transformed to 440 volts or lower, but in the case of a few large units the full line voltage is carried to the motor windings. The induction motors in use range from 1 to 1200 H. P., and motors from 20 to 100 H. P. capacity are numerous. In two or more instances large synchronous motors are operated with the 2200-volt current in their windings. One such case is that of the Geo. Urban Milling Company, in whose works a 400-H. P., 2200-volt, three-phase, 125-cycle synchronous motor is employed, besides one 20-H. P., 220-volt induction motor.

Another interesting equipment is that of the United States Rubber Reclaiming Works, where one 1200-H. P. induction motor, and another of 200 H. P. are operated with the 2200-volt, three-phase, 25-cycle current. In the Snow Steam Pump Works a part of the line energy is converted as well as transformed for the operation of thirty-seven induction motors with a total capacity of 837 H. P., ranging from 2 to 100 H. P. in individual capacity, and of the 440-volt, three-phase type; also for the operation of seventy direct-current motors at 220 volts that are rated at $\frac{1}{2}$ to 50 H. P. each, and have a total capacity of 1194 H. P.

Many of the motors in these large works have taken the place of steam plants that now stand idle, and the motors are, as a rule, belted to lines of shafting rather than geared or direct connected to the individual machines.

Perhaps the most striking instance of the substitution of transmitted electric energy for steam power in Buffalo is that of the pumping plant of the city water works on the lake front. When it became necessary to increase the capacity of this plant some months ago, a vertical centrifugal pump of 25,000,000 gallons capacity per 24 hours, with a direct connected, 2200-volt, three-phase induction motor, was installed for the work.

Standard Third-Rail Conference

IT is reported that the New York Central Railroad has made overtures to all the railroads in the East,—more particularly those entering New York and Jersey City,—with regard to the holding of a conference to adopt a standard third-rail. Though many of the railroads do not contemplate electrification in the near future, it is felt that the possibility of all the lines in the East eventually becoming electrified justifies this move to make it possible for rolling stock to pass from one road to another. Standardization is to be carried out more in the clearance measurements rather than in the type of rail itself.

A school of trades, for which Prof. John E. Sweet is principally responsible, is to be established in Syracuse, N. Y., by a stock company organized with $50,000 capital stock. The charter includes all the industrial arts, but only a machine shop will be built at first. Prof. Sweet is to give a large part of his time to the school without financial compensation.

Simple Steam Turbine Engines

By JOHN RICHARDS

The following paper, presented before the Technical Society of the Pacific Coast by Mr. Richards last year, serves an excellent purpose even at this later date. It supplies comparatively popular information, useful even to the engineer, on a subject which has had elaborate scientific treatment at the hands of others.—The Editor.

IT is a strange fact that the "evolution" of steam turbines is following a course quite the opposite of that of piston engines. In the latter, the constructive part was developed and in a great measure completed before the thermal or thermodynamic features were investigated and explained; and, as a matter of fact, ignoring the modern demands of increased speed and pressure, the constructive feature of such machines has not greatly advanced in recent times.

Some of Watt's steam engines remained in constant use for a century, and many old engines made in this country had a record of 50 years and more; but, as remarked, the thermal or thermodynamic features that pertain to the art have only in recent times become understood and applied. Thirty years past will include what may be called the scientific evolution of piston or pressure steam engines, and with some exceptions, will include the development of their proportions and their arrangement into types.

In steam turbines, the scientific part has preceded the constructive one; in fact, was complete in essential points when their practical construction and use began. This was, of course, because all steam and heat engines are governed by the same general laws, with the difference that turbine or impulsive engines deal with the flow and gravity of steam instead of its pressure, and hence are more complicated in several respects, but, as before remarked, they follow certain ascertained laws which govern heat engines in general.

The problem of constructing turbine engines has, as may be claimed, only begun. Even the types are not yet determined, and no doubt many years will elapse before this branch can reach a successful evolution and constant types appear. Design and methods of construction must arise out of use and experience, and must be proved by the inexorable tests of efficiency, endurance, adaptation, economy and cost.

A principal fact, relating to turbine engines now in use, is that while this term is applied to all kinds of steam wheels driven by impact, reaction, or pressure of steam, there are two types that are quite distinct as articles of manufacture. One of these types I will call "single" acting, the other "stage" acting. These types are best known in common speech by the names of inventors who have in recent times been most prominent in their development; the single acting as the De Laval or Riedler type, the stage or double acting as the Parsons type. Another type, that will have some notice hereafter, is the reaction type, not commercially made at this time, but a "parent" of the whole, as will appear.

The first two named types of engines are also designated as impulse and pressure machines, but these terms do not very clearly define just what is meant; they are, however, as nearly descriptive as any that can be selected for the purpose. The action to be described in these cases will be better understood by saying that one operates by "push" and the other by "blows." One is free running or open, the other inclosed to maintain pressure.

Of steam turbines, those of the stage or Parsons type are at this time the most numerous and the best known, and they have engrossed the thought and skill of many able engineers. They correspond in many respects to inclosed or pressure water turbines of the Jonval, Fourneyron and centripetal types, which act mainly by "push" or pressure, but not by sustained pressure in the same way as in the action of pistons.

The stage or successive action of the steam in this type of engines has for its main object the reduction of speed and rate of revolution, thereby adapting the machines for coupling directly to pumps, dynamos, marine screws and so on. It also avoids the enormous centrifugal strain set up in single-action machines.

Turbines of the single action or impulsive type are open and without maintained pressure, as in the tangential, Girard and other unfilled water-wheels. Consequently they have no running joints to maintain against steam pressure.

Steam and water turbines being analogous in many of their features, and the latter being much better understood, especially on this coast, where water turbines of all kinds are employed, a comparison will aid in the present explanation.

The main distinction between steam and water turbines arises out of the different natures of the two fluids. One is elastic and light, the other inelastic and heavy. In the case of water the velocity of efflux is low and in proportion to its density, reaching a velocity of about 80 feet per second under a head of 100 feet, or a pressure of 43 pounds per square inch; but in steam the velocity is immensely greater. The velocity, in feet per second, of efflux from nozzles equals 60 times the temperature in degrees Fahrenheit plus 460. This gives a velocity of 1680 feet per second for steam at a pressure of 100 pounds per inch; but this is much less than is now assigned for actual efflux from nozzles on which the speed of turbines must be computed. The practical velocity of turbine wheels is computed on a flow of 3000 to 4000 feet per second, and for the vanes from 1200 to 1500 feet per second, or 72,000 to 90,000 feet per minute. This is more than twelve times the rate of the fastest railway trains, and, as a physical fact, almost evades the power of conception.

Otherwise than as to the great difference in their velocity, steam and water turbines follow like laws; the spouting energy, as it is called, being theoretically equal to the gravity; or, in other words, the "blow" is equal to the "push," provided the kinetic energy of the impact or blow can be equally utilized.

The action of all unconfined liquids is expressed in an old rule of fluid motors: The fluid must "enter without shock and leave without velocity." This rule applied to any motor driven by the impulsive energy of a fluid, will determine the correctness

of the machine's operation, or, as it is called, its efficiency, meaning the useful effect produced in proportion

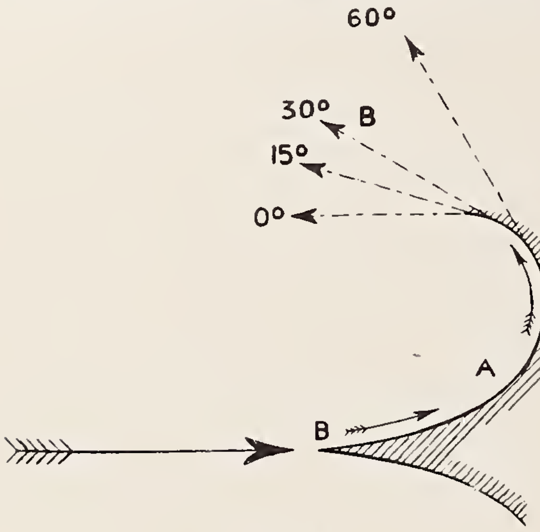


FIG. 1

to the weight and velocity of the fluid consumed.

To further explain this action of fluids, if a stream is directed against a fixed flat surface, only a portion of the energy is imparted to the surface, about one-half in fact. The entry is a shock, and the fluid is scattered in a lateral direction with violence and leaves with velocity. If the same stream of fluid is directed tangentially into a curved vane or bucket, as in Fig. 1, and if its course is gradually reversed, it will leave with velocity, and that much of its energy will be lost; but if the bucket or vane A is set in motion with the fluid at one-half its velocity, then, by the component of these motions, the fluid will be brought to a state of rest, and will leave without velocity, the buckets receiving the total energy less fluid friction and some loss due to the divergence of the lines B. This is the manner of operating in all fluid motors of the impulse type or of single action.

The tangential entrance of the jet or stream and the resultant or discharge angle are very important features in practice, and will be again considered at some length, not in respect to economy alone, but as materially modifying construction in several ways.

Reverting now to the filled or pressure class of turbines for water or steam, these operate in a different manner, by what is commonly called pressure, but not pressure within the usual meaning of this term. "Obstructed flow" comes nearer describing the operation.

The course of the fluid through the machines is made so tortuous or difficult, by means of reversing or baffling curves or vanes, that the gravity or pressure of the fluid acts like a static force.

Fig. 2 illustrates, in an imperfect way, this action, the large arrow, in this as in other diagrams, being employed to show the line of impingement or course of the fluid.

If all the vanes or buckets, A, B and C, were fixed, it is clear that the water would be discharged at G with reduced velocity, even if it were confined; but if the vanes B are set in revolution in the plane at E at half the velocity of the water, it will be left at F in a state of rest or without velocity. If the vanes B are set in revolution at one-fourth the velocity of the water, there will be a residual discharge of force at F, to enter the third set of vanes C, these latter revolving in an opposite direction, so the speed of rotation of any set of moving vanes will be reduced accordingly. If the vanes C are fixed, and discharge into a fourth set of vanes D, the rate of rotation can be

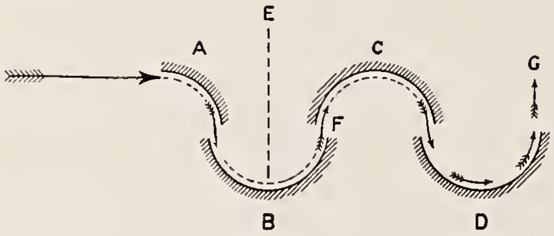


FIG. 2

reduced again as the square root of the water's velocity in the two cases. This is the manner in which the speed of stage turbines is reduced.

The vanes A and B may represent a common water turbine. With the vanes C fixed and those at B and D moving, we have a two-stage steam turbine, except that in all cases the buckets or vanes, whether for steam or water, are of ellipsoidal or other modified curves.

Water turbines of this class have commonly only two sets of buckets or vanes, A and B, for example, one fixed and the other movable. Stage steam turbines have from five to ten sets of vanes, the mobility of the fluid demanding this difference. All motors of this class are called "filled," the induction and eduction passages being approximately of the same size in the case of water-wheels, but increased, of course, for elastic fluids to accommodate their expanded volume.

One other class of motors remains to be noticed, viz.,—the reaction type. Their manner of operating will be more clearly explained later on.

These remarks will, I hope, explain the classes or types of steam turbine motors as now made and in course of evolution; and, with this much respecting the principle or mode of their operation, I will turn briefly to their history and afterward discuss the constructive problems, which, as at first explained, form the principal theme to be dealt with at this time.

It is common to begin the history of steam engines with an account of the "æolipile," made in Egypt about 2000 years ago, by Hero, a Roman architect. This device, with which almost every one is familiar, is illustrated by Fig. 3.

It is an organized steam motor, much better than some made at this day; and, considering the circumstances of the time, was a wonderful production, evincing, as it does, a knowledge of the expansive force of steam; also the principle of reaction. A is a rotative steam-containing vessel, B B are hollow arms delivering jets of steam tangential to the path of revolution C. Supposing the vessel A to be filled with steam from a pipe D at a pressure of 100 pounds per square inch and the area of each jet to be 0.1 inch, or together 0.4 inch, then the pressure on these orifices, if closed, would be 40 pounds. When open, there is no pressure on this area, but an unbalanced back pressure of 40 pounds in the opposite direction, the turning force, due to reaction or unbalanced pressure.

I am aware that a mathematical treatment of this matter would involve the ponderable matter discharged, its velocity and other intricate conditions; but the theory of unbalanced pressure will answer for present explanation.

This Hero wheel was a reaction turbine, and, as such, was a much more complicated and ingenious conception than the direct acting or impulsive wheel of Branca, which followed in 1629, about 800 years after Hero's æolipile.

This latter device can scarcely be considered an invention; but it must be remembered that the expansive

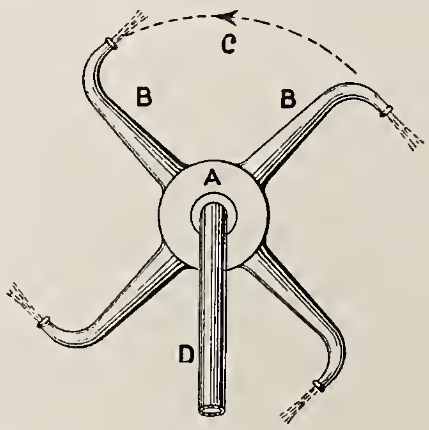


FIG. 3

force of steam was, even at that date, a mystery. No useful application of this device is known, and it was only a toy, consisting of a wheel with flat

vanes against which a jet of steam impinged.

From this point the art seems confined to England, or mainly so, and from 1784 to 1901 there were granted in that country more than 400 patents for machines that may be classed as, or with, steam turbines. These various patents have been recently examined and listed by Robert M. Neilson, an engineer of Manchester, England, who has arranged a chronological list of them in a treatise on "Steam Turbines," published last year.

Even James Watt, John Ericsson, Perkins and other well-known steam engineers "had a try" at these obdurate machines without permanent result, and an inference, to be drawn from the copious array of schemes proposed, is that the principal impediments were in various operating conditions now better understood and mainly the want of resources for constructing machines to move at such great velocity.

There is also the fact that, in so far as principles or modes of operating are concerned, these inventors anticipated about all that is known in the present steam turbine practice, except in the respects just named.

Kemplein's engine of 1774 was a reaction one, with the arms and vents as in the æolipile of Hero. James Watt's machine of 1784 was similar in operation, with this difference, that he proposed to vent the steam under mercury or other fluid. Sadler in 1791 devised a compound machine or one of double action, also of the reaction type. Trevethick in 1819 proposed a reaction machine and John Ericsson in 1830 patented a very well-designed reaction wheel.

In 1843 Pilbrow patented a stage turbine with a large number of fixed and moving vanes or buckets arranged for expansion. Indeed, his machine had all the main features of modern engines of the stage type.

In 1848 Robert Wilson patented the first radial flow steam turbine, which in design fully anticipates the Dow and other radial flow machines of our time. He also proposed a parallel flow engine with expanding chambers or spaces, in the manner of Parsons.

In 1888 Alexander Morton, a well-known engineer of Glasgow, Scotland, made experiments with a steam turbine of ingenious form, and other inventors in Scotland made reaction machines that were said to be applied to practical work; but undoubtedly the principal part in the history of reaction engines was the invention of William Avery, of western New York, who, about 1825, made and put in successful operation a large number of such engines.

Mr. Avery was a near relative of Prof. John E. Sweet, president of the Straight Line Engine Company, of Syracuse, N. Y., to whom I applied some time ago for information respecting the Avery engines. Professor Sweet replied as follows:—

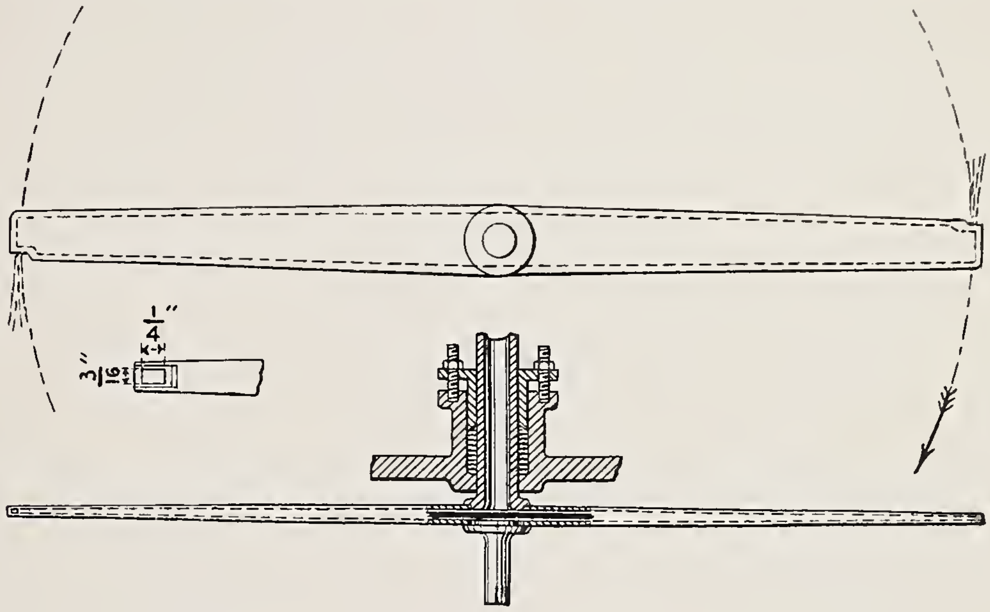


FIG. 4.

"In respect to the history of the Avery engines, these were made 75 to 80 years ago by William Avery, a local mechanic here. There were about 50 constructed and put in use. One of the runners is now in my possession; another, that I saw years ago, had a hollow shaft of perhaps $1\frac{1}{4}$-inch bore. The head or runner was of sword shape, the arm 1 by 3 inches at the center and $\frac{3}{8}$ by $3\frac{1}{2}$ inches at the ends, the diameter swept being about 5 feet. Steam was admitted through the shaft by means of a stuffing box, passed through the shaft to the hollow arms and escaped at a tangential issue $\frac{1}{8}$ inch by $\frac{1}{4}$ inch, at the rear corners of each arm, the ends of which were stopped by plugs brazed in. Owing to the rapid rotation of the arms—10 to 15 miles per minute—the front edges were so rapidly cut away that replaceable blades made of tempered steel were inserted so they could be renewed. The fact that the engine had to be taken to a blacksmith shop every three or four months for renewal or repairs had more to do with its abandonment than its lack of economy. As to the latter, people who knew the facts, or claimed to know, said that when they changed to the common slide-valve engines there was no gain in steam economy over the Avery engine.

"Another feature that worked against the Avery engine was the stuffing box around the shaft, which in the hands of workmen of that time was apt to be set up so as to consume a large part of the power in friction. This was a natural consequence, as the wear was rapid. What the result would have been with a truly ground shaft in a metal bush, instead of a turned shaft and stuffing box, making the issues expanding nozzles and multiple expanding by two or three arms in separate cases and connecting to a condenser, is not known. It might rival a pretty good modern engine, if not the best.

"The Avery engines were used in sawmills and woodworking shops of the time. They had weak starting power, and did not need much for the uses named. They ran at such a fearful speed that the reducing motion was an impediment. Mr. Avery had to employ bands, which were far more objectionable than gear wheels.

"The Ruthven and also the Gorman engines of the same type are mentioned by Professor Rankine in some of his writings and claimed as attaining an economy equal to piston engines of the time."

Professor Sweet sends, with his communication, a drawing of the Avery impeller in his possession. This is shown in Fig. 4, and it must be admitted that the circumstances described, as before remarked, form a principal fact in the history of free-running engines. The economy attained, even if there was no other fact than that of fifty or more engines being made and put into practical use, is enough to amaze one when it is considered that the engines were purely reactive like a Barker water-wheel or the Hero engine in Fig. 3, and that the inert fluid under atmospheric pressure was left directly in the path of the impeller's arms, and wore away the front part where the pieces were inserted. The casing was no doubt of a form to prevent

free revolution of the spent steam, otherwise this impediment would to a great extent have been avoided.

This machine admits of further comment, especially in its constructive features, and I have no hesita-

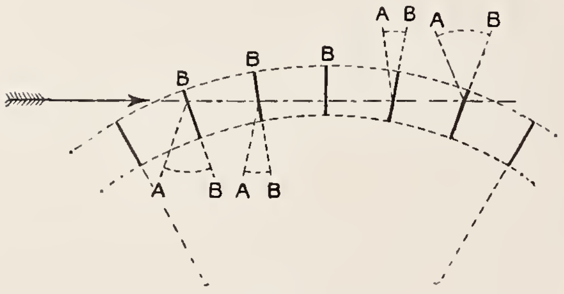


FIG. 5

tion in claiming that the material is in this case better disposed to resist centrifugal strain than in any steam turbine now being made. The speed was no doubt equal to that of machines now constructed. The structure is not exposed to incomputable inherent strains, as continuous wheels or discs must be, and the box section, made of thin metal plates, is the strongest known in the arts.

In a letter received from Charles Brown, of Basle, in 1903, I find the following remarks respecting the Avery engine:—

"Early in the forties an American engineer by the name of Pratt told me that he had experimented with two of Avery's Hero reaction wheels, one with 100 pounds steam running at 45,000 feet per minute. It gave 30.3 H. P. and consumed 7½ pounds per horse-power hour, and another with 130 pounds steam giving 24½ H. P. consumed 6.16 pounds running at 54,000 feet. Diameter at nozzles 5 feet. If these data are correct the result compares well with a 30-H. P. Laval, which, non-condensing, consumes fully as much coal as the old Avery.

"Pratt told me that Avery had built a locomotive with his wheel. Avery's engine had the advantage over the Laval that the number of revolutions, 2800 to 3600 per minute, is so low that it might be used for driving many machines without the intervention of gearing, so that it might be worth while to take up the study of the Avery again, for the wear and tear of the Laval gearings are heavy. For heavy work, the Parsons is not likely to be superseded for some time yet. Brown, Boveri & Company are crowded with orders, and the works are in a chronic state of expansion; the large sizes are so much more economical that the piston people have no chance. Latest test gives 8 pounds per indicated horsepower hour."

The next step in practically applying the free-running steam wheel to useful purposes was, so far as I know, by Dr. De Laval, of Stockholm, Sweden. I was often in Sweden during the earlier experiments there, and imbibed a curiosity and interest in this matter that have lasted ever since, especially since coming in contact with the tangential type of water-wheels on this coast. These latter are operated under pressures much greater than has been attempted with steam motors; that is, up to 900 pounds per inch, giving a velocity of 120 feet per second. I believe, and I shall attempt to show, that such wheels are made on a system much in advance of steam turbine practice in some very important respects.

Following Dr. De Laval and perhaps others in steam turbine wheels of single action, came a successful division into stages by Hon. A. C. Parsons, one of the most eminent steam engineers of our time. This subdivision, it may be called, of the steam turbines, had for a principal object, as before pointed out, a reduction of the speed of wheels and their adaptation to direct driving of dynamos, marine pumps, screws and the like, offering uniform resistance or load.

Wheels or engines of this type involve the maintenance of running steam joints between the stages, and demand workmanship that is now and will likely remain a bar to their general manufacture. There is also an inability to endure lateral stress on the spindles, because the running steam joints that separate the stages of pressure have a clearance of about 0.01 inch. These latter features have confined the engines to purposes where simple torque is delivered, but this includes a great part of the whole field of motive power.

Parsons' modification of these engines has called out scores of inventors and imitators in this and other countries, and it seemed for a time as though the De Laval engines were to remain sole representatives of the single-action system; but a reaction has begun, most notably in Germany, where Professor Reidler, the author of "Indikator Versuche auf Pumpen" and much other noted work, has, in conjunction with Pro-

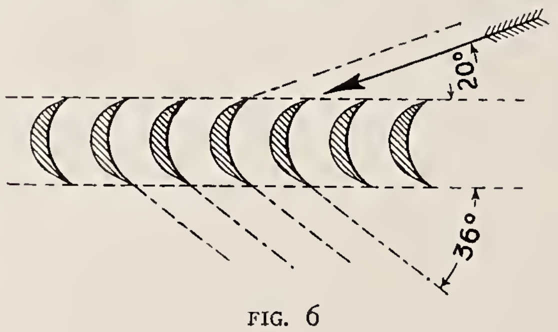


FIG. 6

fessor Stumps, produced single-action engines up to 2000 H. P., apparently of durable but expensive construction. I have drawings of these engines, accompanied by German text, with a list of engines in operation up to November of 1903.

There have been scores of abortive attempts in single-action machines, and no doubt there will be many more, because the problem, as a constructive one, offers a fertile field for the contriver incapable of understanding the impediments to be overcome.

The mechanical construction of machines should be approached by analysis of their operating conditions.

These latter are not amenable to computation, except a few, such as the strength of material, normal strains, endurance or wear and so on; but beyond these things lie what may be called the "phenomena of operation," that must be learned by

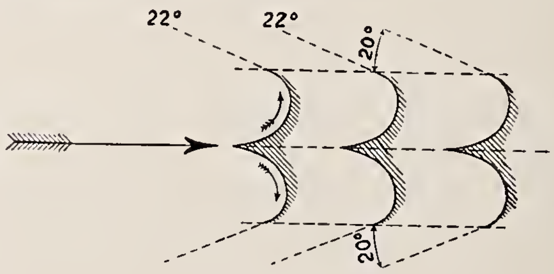


FIG. 7

observation, inference, analogy, and, for the most part, empirically.

To illustrate what I mean:—The generation of electric current by dynamos was a well-founded science long before there were durable and reliable journal bearings for the armature spindles, and these are now a survival from endless modification. The commercial factors of symmetry, cost, endurance and many other qualities belong in the same category and are not computable.

It is not usual, in papers of this kind, to introduce the subject of constructing and operating machines, and it might be out of place in papers relating to some kinds of machines employed in the arts; but, as before pointed out, information on this subject is, at this time, the lacking element in steam turbine practice.

At the risk of prolixity I will summarize, and restate in a compendious way the points already gone over, and then proceed to constructive features.

All fluid machines belong to two classes:—

First, machines that receive and translate the force of fluids or motive engines of all kinds. Second, machines to impel fluids, including pumps of all kinds. This is a di-

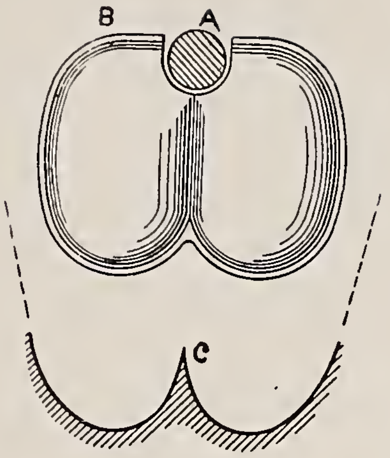


FIG. 8

vision easily understood. Fluids include air, steam, water, gas, all of which come under and are amenable to certain ascertained laws, and are divided into elastic and inelastic fluids.

Fluid motive engines are divisible into two classes—positive and free running. The positive class includes all that operate with pistons and which measure, positively and in proportion to movement, the amount of fluid that passes through them. There is no time factor in positive-acting machines; hence the rate of movement and the work done in a given time are under control. Within certain limits a positive-acting machine may run fast or slow, and its speed can be varied at will. The latter is the most important advantage that positive or piston machines have over the impulsive or non-positive type, and lends itself to a wide field of uses.

This advantage of a variable rate of movement is, however, diminishing all the time, because of the improvement in transmission gearing, designed to change the relative rate of movement.

The free-running class of fluid machines, those which operate by impulse and reaction, have a "time function" to deal with, and their speed is a determinate quantity, based upon the flowing velocity of the impelling or impelled fluid. This class embraces water-wheels of all kinds—gravity, impulsive and reacting; also steam turbines.

The velocity of this impulse class of machines is inversely proportional to the density or weight of the fluids that impel them. A centrifugal pump and a rotary fan seem very different machines, but they operate according to the same law, and their speeds are inversely proportional to the weights of the fluids, or as 800 to 1. This indicates the great velocity at which single-action steam turbines must move, practically about 90,000 feet a minute.

Such a velocity produces various phenomena, such as the disturbance and stretching of the rotative parts by centrifugal strain; tendency to vibration, noise, the heating and wear of journal bearings and other things. The centrifugal strain can be imagined when we reflect that 1 pound of metal, on the periphery of a wheel 2 feet in diameter, will, at a speed of 10,000 revolutions per minute, represent a centrifugal force of 34,000 pounds or 17 tons.

Referring now to the constructive features of steam turbines, the first thing considered will be the buckets, and at the beginning I will claim that these are at fault in modern practice because of being curved in one plane only; consequently they have but one correct position in the jet throughout the whole arc of their movement and in nearly all cases are cut out of solid metal, and have angular or imperfect corners.

This form of bucket is due no doubt to the difficulty of machining their surfaces except in straight lines, but it produces, in turbine wheels, several features of construction that are far-reaching in effect, also far from apparent until carefully examined.

First.—It increases the weight and number of buckets about fivefold in the attempt to secure impingement of the steam jets normal to the straight faces of the buckets.

Second.—It distorts the course of reaction from a possible angle of 15 degrees to an angle of 20 to 30 degrees required to secure clearance.

Third.—It makes necessary a side application of the jet, introducing lateral stress on the wheels and inducing vibration.

Fourth.—It augments, in proportion to the added number of buckets, the amount of fluid friction, but does not include the resistance of corners.

Fifth.—The disposition of material in solid discs prevents the employment of its fibrous or laminated nature in the direction of strain and demands very expensive homogeneous material, a result not in accordance with the numerous buckets.

This is a bold arraignment of certain constructive features, and would require great temerity on my part to bring forward were I not fortified by something stronger than inference and personal experience in this matter. I allude to the tangential water-wheel practice on this Coast, which has passed through a crucial course of development that furnishes copious suggestion for single-action steam turbines.

The number of buckets is a very important matter. It is a sequence of the angle of impingement, and this again is a sequence of the bucket's shape, as will be shown further on. The surface or fluid friction, which offers a considerable resistance and loss, is in proportion to the number of buckets employed, and should be considered in this connection.

Most of the steam turbine buckets now made have angular corners, and, when there are not such corners, the end walls of the buckets are so distant from the jet as to lose reactive effect in that direction. We long ago learned to keep water out of sharp corners in buckets.

In respect to the number of buckets or vanes, Fig. 5 shows how the

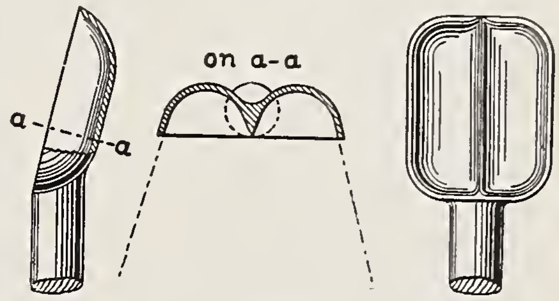


FIG. 9

line of impingement varies in respect to the straight faces of radial buckets, being as the sine of the angles A and B; and there is no way of securing impingement even approximately normal to the straight faces, except by employing a large number of buckets set close together. The result is much the same whether the jets be applied on the side or tangentially, as shown in Fig. 6, where the angle of entrance is 20 degrees and that of discharge 36 degrees.

The trend of practice in tangential water-wheels has been to wider spaces between the buckets, better angles for discharge, and, recently, to uniformly curved buckets, as hereinafter explained.

This feature of oblique impingement is accountable for at least three-fourths of the buckets now employed.

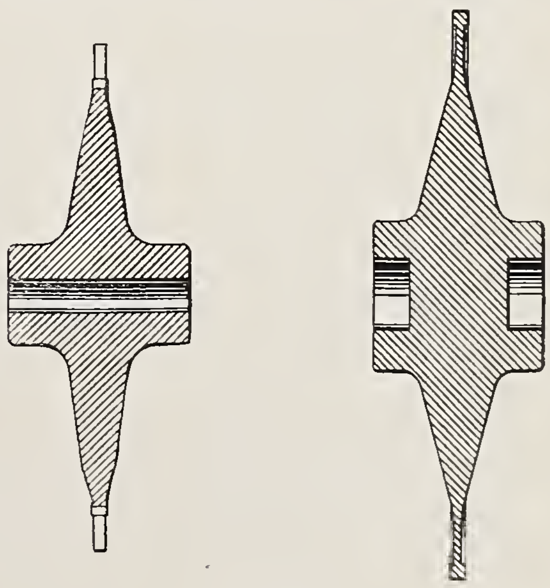
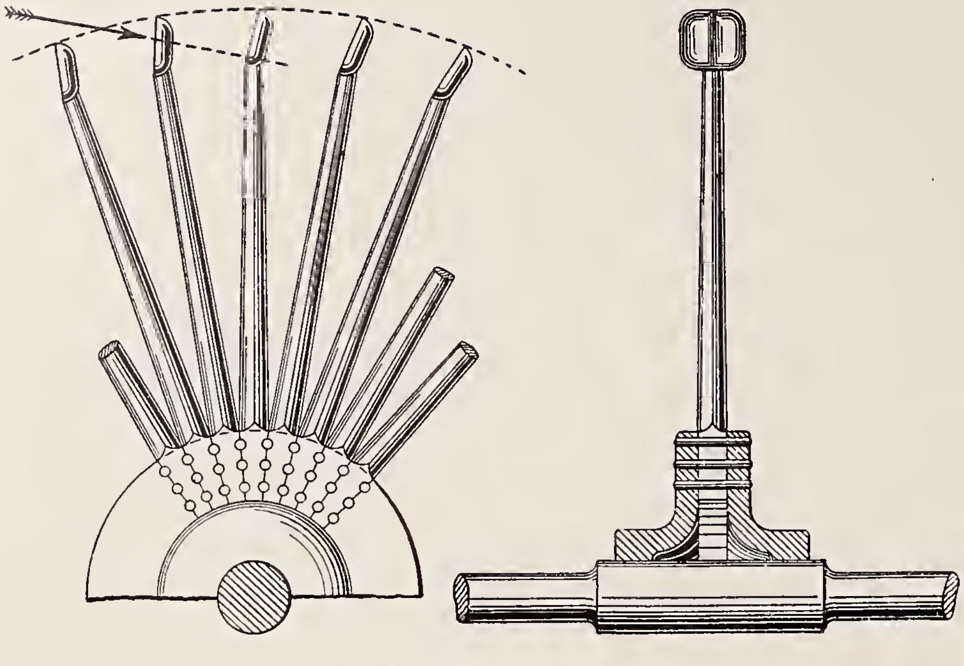


FIG. 10



FIGS. 11 AND 12

and the result is loss by increased surface friction and distortion of the angle of reaction.

Fig. 6 shows approximately the entrance and discharge angles in the De Laval engines, embracing an arc of 56 degrees, which, by reducing the number of buckets, could be reduced to 36 degrees or less if the problem of oblique impingement were out of the way. Fig. 7 shows spacing for tangential buckets to secure an easy discharge at 20 degrees.

In the Riedler turbines, the angle of discharge is 180 degrees. In other words, the discharge is opposite the jet, but this calls for increased surface, more width and weight for the revolving member, and expensive work in construction, which are hardly offset by countervailing advantages, and which certainly prevent a cheap and general manufacture of the machines. It would not be becoming in myself to criticise the computations and designs of Professor Riedler, but I am looking at the practical and mechanical phases of the problem, and seeking means whereby such engines may be made at a reasonable cost by common facilities and operate at reasonable efficiency.

The contention is that the buckets of steam turbines should be curved in all planes approximately as shown in Fig. 8, taken from a form of water buckets of a very advanced type by W. A. Doble, of San Francisco. These are of double concave or cup form, in order to permit direct and balanced impingement at the various angles in which they are presented to the jet, and have a central dividing wedge to permit tangential application. This latter is not presented as a new idea, being simply the final form and method for tangential water-wheels on the Pacific Coast, after more than 25 years of continuous experiment and the attainment of an efficiency that is, if not final, so nearly so that a very narrow margin of avoidable losses remains.

If there exist any reasons why this same system or method of operating is not applicable to buckets for steam, I am not able to perceive them. Of course, expansion of the steam and divergence of the jets would call for modification not determinable until a form of nozzle and the contour of the jet are assumed.

Not knowing how far the contour of a jet of steam will permit its passage through notch A, in Fig. 8, I am not able to say how far this feature is applicable to an elastic fluid, or how far such a passage as that at A would become a spillway when a jet was impinging at the opposite end of the bucket. I will not discuss this here, further than to point out that this passage A avoids passing the rim B of the bucket through the jet and the disturbance that must result from this cause.

The dividing wedge C permits tangential application of the fluid and produces a shallow and balanced discharge. As a feature of impulse fluid motors, it has not met with analysis and adoption except on the Pacific Coast and in the Riedler turbines. Its function, or rather its effect, is not always understood. The avoidance of side stress on wheels, especially on steam turbines at their enormous speed, is important, and so is the dual discharge which permits a more nearly uniform velocity throughout the discharged water section, because the latter is shallower. After many years of practical experiment, as well as some spent in scientific work, the dividing wedge was confirmed at the University of California in 1883* as a permanent feature of good practice for water.

In Fig. 9 is shown a form for buckets capable of receiving and properly reversing a jet of steam, and permitting the number of buckets to be reduced to what will come within and cover the divergence or expansion of the steam jet, or about one bucket for each 8 degrees of arc for wheels from 20 to 40 inches diameter.

This is less than one-fifth the number now employed for wheels having buckets straight in one plane, as in Fig. 6.

Such buckets can be stamped out of fine steel and made strong, smooth and integral with their radial supporting stems. They can be made of uniform thickness, with no more metal than their operative functions require, and of less than half the weight of those cut from solid metal, so that, compared with the usual form of steam turbines, there would be one-fifth the number and (excluding the fastenings) less than one-half

* Partial Turbines or Tangential Water-Wheels. College of Mechanics, Berkeley, Cal. By Ross E. Browne.

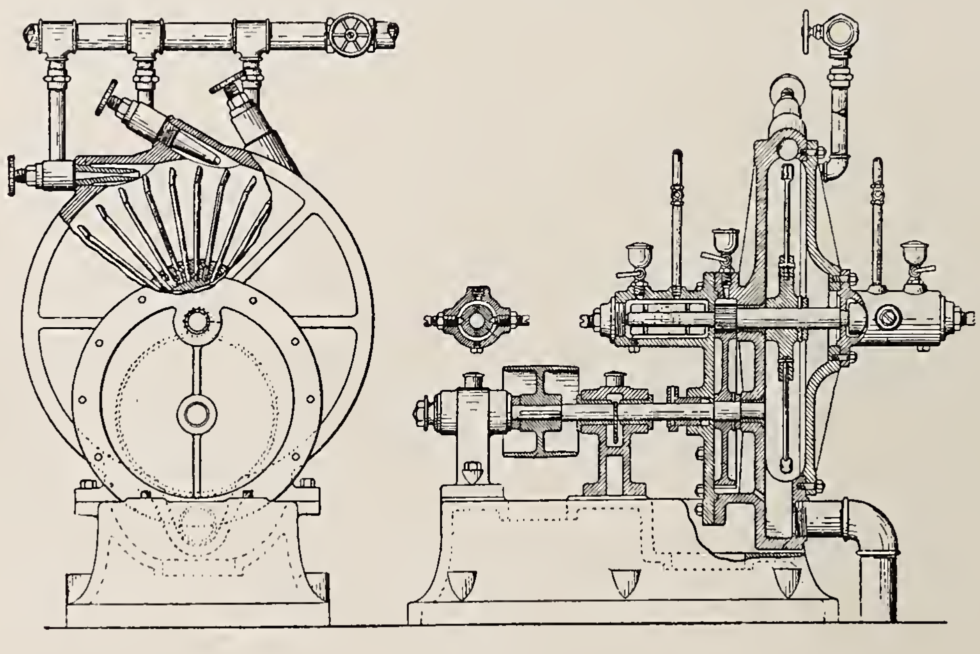


FIG. 13

the weight, so that the mass in the rim of a turbine wheel with this form of buckets can be reduced to one-eighth or even one-tenth of that in common practice.

In the construction to be hereafter suggested, the buckets represent and constitute the whole rim of a wheel.

As to wheels or discs, nearly all now in use for single-action engines are solid discs, as shown in Fig. 10, a matter much to be wondered at if we consider the strains. Not everyone has had the opportunity of seeing discs at high revolution, circular saws, for example, which, at a speed of 10,000 feet per minute, assume a sinuous path at their peripheries and lose their stability by stretching.

A bucket weighing an ounce, and revolving in a circle 24 inches in diameter at the rate of 10,000 revolutions per minute, will exert a centrifugal strain of one ton, and its supporting sector and fastenings will exert 50 per cent. more—a result scarcely conceivable. The disposition of mass, strains and section may mathematically produce a body of the form shown in Fig. 10, but I do not believe that practical experiment will evolve anything of this kind.

Assuming this centrifugal force applied to a sector of a solid disc of uniform section, a circular-saw plate, for example, the error of such construction becomes apparent. The disposition of the material, in a sector of the wheel of which the bucket is the outer end, will be inverted, so to speak, and disposed inversely as the strain. The perimeter has no function requiring a continuous mass there, unless it be to hold a series of buckets set close together or to provide mechanical fastenings for them.

To compensate this contradictory disposition of material, the wheels are commonly made in lenticular form, as shown in Fig. 10, so that the mass of a sector is approximately a radial body of nearly equal section, apparently providing for centrifugal strain if change by elongation is ignored; but this latter is the principal fact of all, and one which cannot be provided for in a solid disc of any form, because the conditions are not ascertainable. I have made diagrams to show the mass in 10 degrees of arc, for several forms of wheels, but want of space prevents their reproduction here.

I have had made, by a very competent engineer, an analysis of the strains in several forms of solid discs, independent of elasticity and of change by stretching, a condition that defies computation in metal forms of the kind. It is an interesting and also an intricate problem, but I believe of but little practical value.

A very extensive analysis of such discs or wheels, made by Frank Foster, was published in "The Engineer," London, for January 8, 1904. It is a study in mathematics of a very abstruse and no doubt interesting nature to students in calculus, but the weight and cost of such discs, if there were no other reasons, preclude their use for plain simple engines, such as those to which these remarks are directed. Professor Riedler seems to disregard such theories respecting the disposition of material in his discs.

I have shown how four-fifths or more of the weight in the periphery or rim of such wheels can be dispensed with, and I will suggest for the body of the wheels a construction which will eliminate inherent strains due to elongation or stretching, and at the same time dispense with the greater part of the mass and reduce the centrifugal strain accordingly.

In wheels moving at such high velocity, certainly the first thing should be to remove from the disruptive zone all joints and mechanical fastenings. These must necessarily include an extra mass of inert material at the points of juncture, plus bolts, rivets or other means of attachment. Buckets or other parts fastened by dovetail joints are open to the same objection, because extra substance must be added to endure compression and holding strain.

The construction shown in Figs. 11 and 12 is suggested, the buckets being made independent, avoiding circumferential strain and permitting free elongation by centrifugal stress. The various spokes are tapered, so that their sections will stand the centrifugal strain within the mass lying outside of any point. They are fastened in a nave by welding or by suitable mechanical means, the strength of which will equal their section.

The nave of the form shown in the diagram will not expand and become loose on a spindle with the amount of weight in a wheel constructed as shown.

In respect to gearing for transmission, I believe that the principal impediment is a want of confidence. Nowhere in the arts have we been called upon for translation at such high velocity; consequently we are not prepared to provide devices such as are required to reduce the speed of single-action steam turbines, where the elements of transmission have to move from 4000 to 6000 feet per minute. I know of no reason why plain tooth wheels, or tangent gearing, will not run at this speed, and I confidently expect that they will do so without any objectionable result.

Respecting tooth gearing there is much apprehension, which arises from the difficulties of constructing it in perfect form. In the Continental Hotel in Philadelphia a screw elevator was in use for more than twenty years. A bevel wheel of 5 feet diameter and a pinion of 10 inches diameter drove the screw, and they were absolutely noiseless. They were made at the Industrial Works in that city, where I was working at that time.

In an experiment made many years ago, at the works of William Sellers & Company, to test the ultimate speed of transmitting apparatus, bands of one kind or another were employed up to a point of failure, then plain spur wheels were resorted to, and, as I have been informed, they were entirely successful to the point of disrupting a steel disc driven by the gearing. Of course, such gearing to run without noise must be perfectly made; and, if there is reason why they will not transmit at 4000 to 6000 feet per minute, I fail to conceive it, especially when inclosed in the turbine wheel chamber, as hereafter suggested.

Twenty-five years ago I constructed machines in which bands of flax webbing ran at 6000 feet per minute without difficulty. These bands drove spindles at 12,000 feet per minute, and the machines are yet in use in Columbus, Ohio, where they were made in what might be called a country shop.

For a good many years I was engaged in designing and making machines in which the spindle bearings had a velocity of from 2000 to 3000 feet per minute, were subject to lateral strain and mounted in weak framing, and they ran cool when the fit and alignment were good. Consequently I am in no way alarmed at the requirements in steam turbine practice, and I confidently expect to see power transmitted by bearings moving at a surface velocity of 5000 feet per minute and spindles run cool at 10,000 to 15,000 revolutions per minute.

In my opinion, the gearing of transmission should be inclosed with the motor wheel, and should operate in the vapour contained in the casing, that being open to a condenser. There are three reasons for this:—(1) The better performance and wear of wheels when steam lubricated; (2) the absorption of noise, if that be present; and (3) the avoidance of packing glands on the spindle of the motor wheel, a very objectionable feature, present, I believe, in all the steam turbines now made.

Such packing glands are objection-

able not only because of a possible resistance and loss of power by friction, as pointed out by Professor Sweet, but because they permit the entrance of air into the condenser and involve the wear and care of packing.

The interior of the wheel casing should be annular, turned smooth and otherwise so arranged as to permit the free revolution of any vapour it may contain. It has been suggested that a sector or spoke construction of the wheels would cause serious resistance by windage or fanning the steam or vapour in the casing; but the attenuated vapour in a casing, 10 to 12 pounds below the atmosphere, would not offer much resistance if fixed, and perhaps none to consider at all if free to revolve with the wheel.

In respect to bearings for the wheel spindle, these should be parallel, hardened and ground, mounted in pivoted split shells of cast iron, and, like the reducing gearing, inclosed in and exposed to the vapour of the wheel chamber. This may seem objectionable because of heat, and it would be so in machines as now arranged, with the casing exposed to a high temperature.

This latter I believe to be a mistake. No avoidable heat should be communicated to the casing to raise its temperature above that of the expanded steam. A low temperature would not cause appreciable thermal loss in the jet, but would assist a condenser and conduce to other desirable objects that have been named.

In respect to nozzles for buckets, such as have been suggested, it is a difficult subject without experiment and when the contour of a jet at different pressures is not known. I am of the opinion, however, that if inclosed the tube should conform to the natural contour of the jet. With side application of the steam on buckets flat or straight in one plane, there is no doubt a gain results from the use of a diverging nozzle, but in buckets in which the jet is divided the case is different.

On the whole, I think it safe to assume that the form of nozzles for steam turbines of the single-acting type is not a problem that will much interfere with their successful construction. That there should be a converging anterior chamber, a throat to determine volume and a diverging nozzle is obvious, but further than this the result is no doubt a refinement that has more importance in a mathematical theorem than in the workshop.

Some years ago, I think in 1901, I asked Mr. Brown, whom I have several times quoted, his opinion respecting steam-motor nozzles. He replied as follows:—

"As regards the De Laval nozzles, the learned here are of various opinions as to their value. Professor Meyer, in Zurich, who has experimented long with the De Laval, says that it is in no way superior to a common nozzle."

The views and suggestions which I have had the privilege of advancing here have been imperfectly embodied in an organized mechanism, shown in Fig. 13. This drawing was made about two years ago, and it would be modified in various ways if reproduced now. It, however, embodies most of the features that have been suggested.

I presume this presentation of a subject, without the scientific furtherance common at this day, can hardly be considered a conventional contribution to the art. It may not be so accepted, but I venture the prediction that the evolution of cheap steam turbines, adapted for general manufacture and use, will before long result from effort and experiment on the part of intelligent and experienced mechanics aided by scientific data.

This assumption has some answer in the fact that, already mentioned, 75 years ago Mr. Avery, a country millwright in western New York, made successful reaction steam turbines, and applied a large number of them successfully to common rough uses. He also made impelling members which contained about one-tenth of the material now employed, and, as I believe, in a more practical manner than in many wheels now being produced. The work was done in blacksmith shops, at a time when accurate tools and processes were almost unknown, and I am much inclined to agree with the opinions of Professor John E. Sweet, whose skill and judgment no one is likely to question, who, in a recent letter to the author, said:—"If I were to engage in the manufacture of steam turbines I would begin with the Avery one."

The steam turbine practice of our day is the finest example of constructive engineering work that the world has ever seen. It is confined to large units, not because of operative impediments in small engines, but because these cannot be furnished separately at such prices as can be obtained.

From these premises I conclude that future steam turbines for common use will be single acting and condensing whenever possible, with wheels of sector construction as light as can be made. There will be no packing glands on the main spindles, and the first movers for transmission will be plain spur or tangent gearing.

I will conclude this paper with brief mention of the economic results that have been reached with steam turbines, as illustrated by the generating engines recently constructed in Switzerland, one with very high-class piston engines and one with turbines, each of 5000 H. P. The results were as follows:—

Weight of piston engines and generators, 598 tons. That of the turbines and generator only 78 tons, or nearly 8 to 1. The steam consumption by the piston engines was 11 pounds per indicated horse-power, and for the turbines 1 KW. with 14 pounds of steam, or about 10 pounds per horse-power. Oil consumption was as 20 to 1 in favour of the turbine, and attendance about 5 to 1.

The piston engines were made by Messrs. Sulzer Bros., of Winterthur, and the turbines by Messrs. Brown, Boveri & Company, of Baden, in Switzerland. The quantities were furnished to me by Mr. Brown, of Basle, Switzerland, with whom I had personally discussed the subject some time before the tests were made and who had forecast the result with much accuracy.

First Used Word Electricity

NO one, recently remarked Prof. Sylvanus P. Thompson in "The London Times," seems to have recalled, in connection with the commemoration of Sir Thomas Browne at Norwich, that he was the first person to use the word "electricity" as a noun. Gilbert and others who followed him had adopted the term "electrics" to denote substances which, like amber, became attractive when rubbed; but they had used no name for the unseen itself.

The first occurrence of the substantive in English (or, for that matter, in any language) occurs on page 79 of the "Pseudodoxia Epidemica" (1646) in the following passage:—"Glasse attracts but weakely though cleere, some slick stones and thick glasses indifferently; Arsenic not at all; Saltes generally but weakely, as Sal Gemma, Alum and also Talke; nor very discoverably by any friction; but if gently warmed at the fire and wiped with a dry cloth, they will better discover their Electricities."

A subway system for electrical wiring is now under way in Havana, Cuba. This is the first of its kind in the island.

Tendencies in Electrical Instrument Design

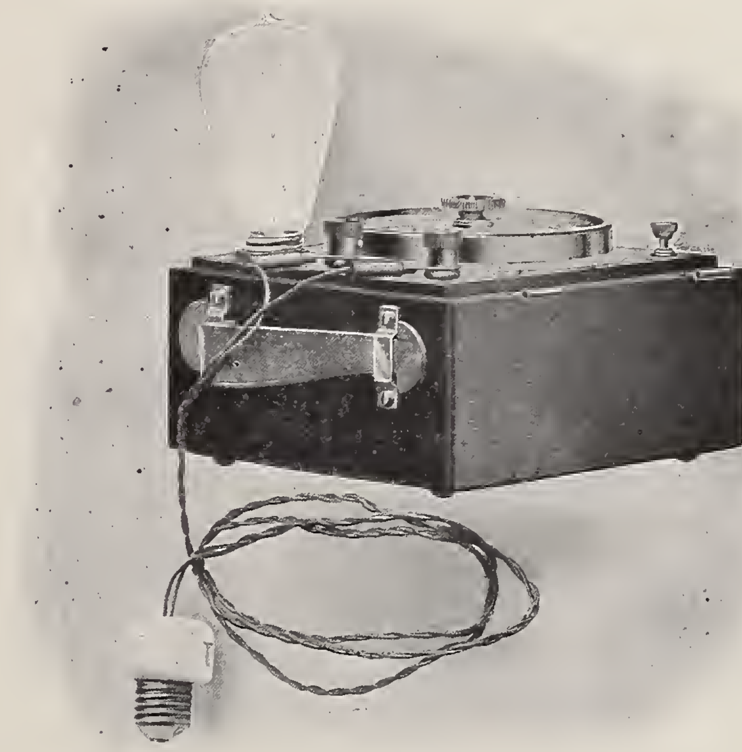
By H. S. KNOWLTON

THE development of measuring and indicating instruments has always been an interesting feature of electrical work. As the applications of electricity on a commercial scale have increased, the importance of securing reliable instruments for both switchboard and portable use has become more widely realized, and a great deal of time and money has been expended by the manufacturers to meet the exacting specifications of modern practice.

Few of us appreciate the debt which electrical progress owes to the instrument designer, for it is only through his efforts that the evidence of tests and experiments has become sufficiently accurate to justify far-reaching conclusions as to the efficacy of machine designs and the operating economy of actual installations. Omitting the consideration of laboratory apparatus, it is interesting at this time to examine some of the more recent tendencies in electrical instrument design in so far as they bear upon economical operation.

In striking contrast to the equipment available in the early days of electrical development, the modern electrical engineer has at his command a variety of commercial instruments little short of bewildering. Direct and alternating-current voltmeters, ammeters, wattmeters, power factor meters, frequency indicators, synchroscopes, curve drawing and integrating instruments in a wide range of capacities present themselves for consideration in each new installation. The selection of this equipment is no longer the simple task it was in the old days of voltmeters, ammeters and recording wattmeters; it is no easy matter to decide between instrumental necessities and luxuries, and the complication of switchboard wiring introduced by these later requirements has become so great that the study of auxiliary circuits is a far more difficult matter than the interpretation of the main power wiring in any modern station.

The tendency toward the remote control of switches is likely to be followed in the near future by a more general extension of instrument circuits to a point beyond the main switchboard, where the relay manipulations and the measurements can be carried out with greater freedom, as at Niagara Falls. The old idea that the entire controlling and measuring apparatus of a plant must invariably be bunched into the cramped area of a single switchboard is no longer tenable, and the development of the



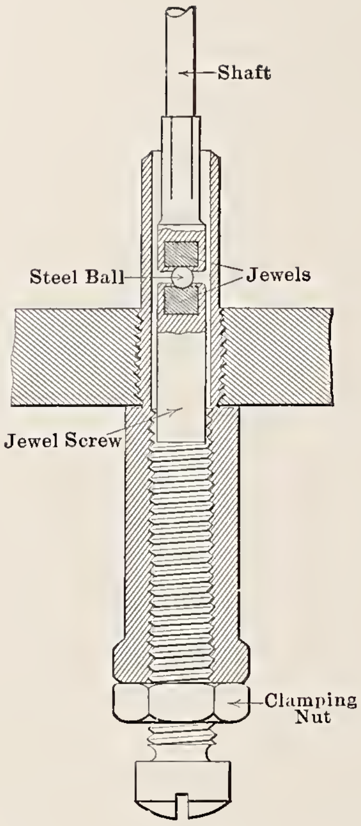
A WESTINGHOUSE LAMP TESTERS' PORTABLE VOLT WATTMETER

A Station Wattmeter for Polyphase Circuits

A Frequency Meter

A Portable Polyphase Wattmeter

ELECTRICAL MEASURING INSTRUMENTS MADE BY THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, PITTSBURG, PA.



CROSS-SECTION OF THE BALL-AND-CUP BEARING USED IN THE WESTINGHOUSE PREPAYMENT WATTMETER FOR TWO-WIRE SINGLE-PHASE CIRCUITS

high-tension motor-operated oil switch is largely responsible for the change.

In selecting instruments for any class of service it is important to thoroughly appreciate the conditions under which they are to be used. This point was well brought out by F. P. Cox in a recent paper before the American Institute of Electrical Engineers, who stated that the conditions on a central station switchboard do not permit of laboratory accuracy, nor does the information derived from such readings require so exact a determination of values. An ammeter best suited to laboratory conditions would have too large a shunt loss for switchboard use, and an instrument designed for the latter work would have too great a temperature even for laboratory service.

Excellent accuracy, however, is now found in the better makes of commercial instruments. In indicating instruments the errors are due either initially to parallax, coarse graduations, friction, or proportionally to inaccurate calibration, variations in the standards employed, and to causes varying the constants. The Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., publishes the following equation to determine the maximum error at any point with which the readings may be relied upon:—

$$\text{Per cent. of max. error} = \frac{aC + bc}{c}.$$

Here a represents the initial errors, b the proportional errors, C the full-scale reading, and c the actual reading. In this company's portable instruments the value of a for voltmeters and milliameters equals 0.001, and the value of b = 0.002; with ammeters and wattmeters, a equals 0.002, and b equals 0.003.

The accuracy of the instruments made by the Weston Electrical Instrument Company, of Newark, N. J., has long been celebrated, and for many laboratory experiments the error of the commercial types is not great enough to preclude their use. This company also manufactures instruments for purely laboratory ser-

AN EDGEWISE INDICATING WESTINGHOUSE AMMETER FOR ALTERNATING-CURRENT CIRCUITS

vice, but the guarantees of the commercial apparatus are suggestive of the painstaking efforts of their designers.

The Weston direct-current portable voltmeter has a temperature correction of not over 0.25 per cent. between 35 degrees and 105 degrees F., and the instrument readily gives results within 0.2 per cent. if the instructions are carefully followed. In special cases these instruments are supplied with an error of less than 0.1 per cent., which means the determination of the e. m. f. of a storage battery cell within 0.002 volt. The temperature correction of the portable ammeter for direct currents is less than 1 per cent. between 35 degrees and 105 degrees F. The standard Weston millivoltmeter for ampere measurements is correct within 0.2 per cent., and the indicating wattmeter for direct and alternating currents has a

A WESTINGHOUSE POWER-FACTOR METER

maximum error of 0.5 per cent. Station instruments for switchboard service are not required to be as highly accurate as portable apparatus used in testing, but an error of 1 per cent. need not be exceeded in many cases. The small Weston ammeters, designed for dental and surgical work, are guaranteed within 0.5 per cent. The sensitiveness of some of these station instruments is remarkable. On one ammeter of 1200 amperes capacity, the effect on the pointer at any point of the scale, caused by turning on or off a single incandescent lamp, can be noticed by a careful observer.

The problem of securing minimum friction in bearings, with consequent long life, has been a troublesome one for meter designers, and many efforts have been made to solve it. The sapphire and the diamond are the only two materials which thus far have been found to be suitable for meter jewels. Until quite recently it

A WESTINGHOUSE PRECISION WATTMETER

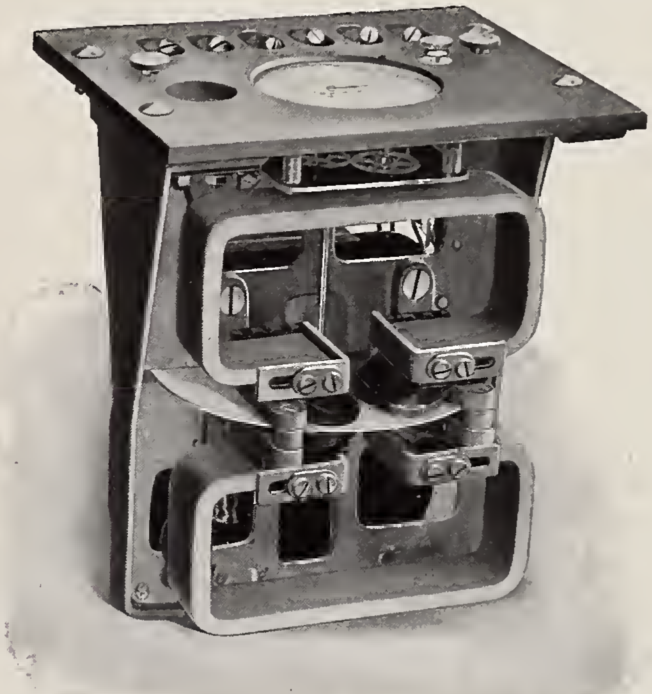
was thought to be impossible to properly cut and polish diamond jewels for this purpose, and when they were used in their natural flat state a ring-stone of sapphire was necessary to keep the meter pivot in the center of the diamond. Such a thrust bearing was used largely in meters with heavy moving elements and in cases where considerable trouble was apprehended from extraneous vibrations. The additional cost of the diamond-jewel bearing proved to be a small matter in comparison with the increased light-load accuracy of the meter so equipped.

A short time ago the General Electric Company, of Schenectady, N. Y., perfected a method for grinding and polishing diamonds in concave form, and it is claimed that a surface is thereby secured which is unsurpassed even by jewels having a flat face. Diamond bearings are practically indestructible, and are, therefore, especially adapted to the conditions under which large meters have to operate. They do away with the slightly erratic speed sometimes noticed at light loads in meters having flat diamond jewels, caused by the additional friction due to occasional contacts of the pivot and the ringstone. In the latest General Electric meters, the pivot is of brass, into the end of which is forced a small piece of piano wire, drawn under very heavy pressure to give a fine grain. This wire, glass hardened and polished, constitutes the bearing surface of the revolving parts.

The Westinghouse Electric & Manufacturing Company has also given much attention to the problem of meter bearings, and their prepayment integrating wattmeter for two-wire single-phase circuits illustrates an improved form of ball bearing, which consists of a 1-16-inch highly-polished steel ball between two sapphire-cup jewels. The upper jewel is inverted and mounted in a removable sleeve, which fits on the base of the shaft. The steel balls are inspected under a high-power microscope before acceptance, and are kept in watch oil when not in use.

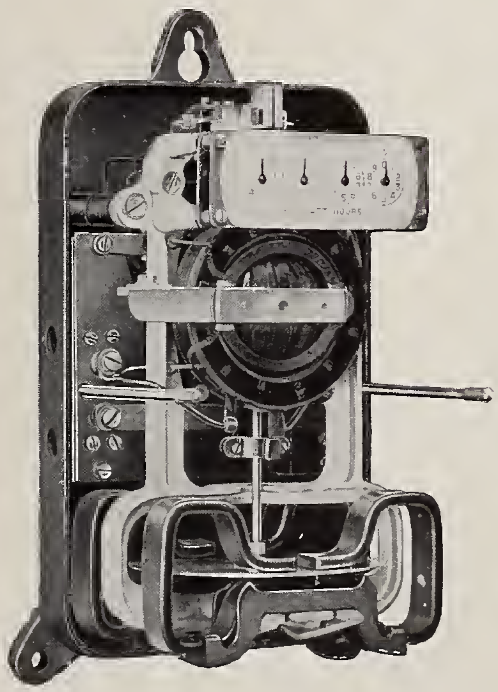
The advantages of a long scale have lately been recognized by designers, and instruments are now on the market in which the scale subtends an angle of 300 degrees. The result of this is that the divisions are long and open, the marking being exceptionally distinct and easily read.

A High-Torque Induction Test Meter with Cover Removed, Showing Cord and Switch for Controlling the Meter

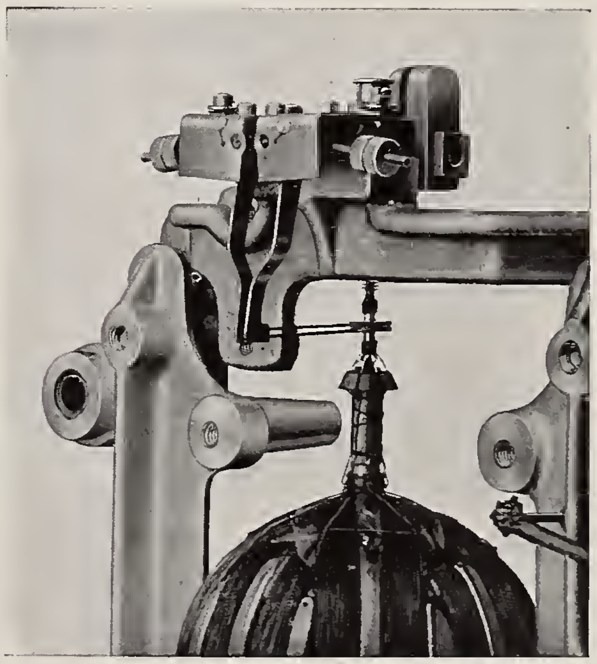


The High-Torque Induction Test Meter Removed from its Case

The Thomson Recording Wattmeter

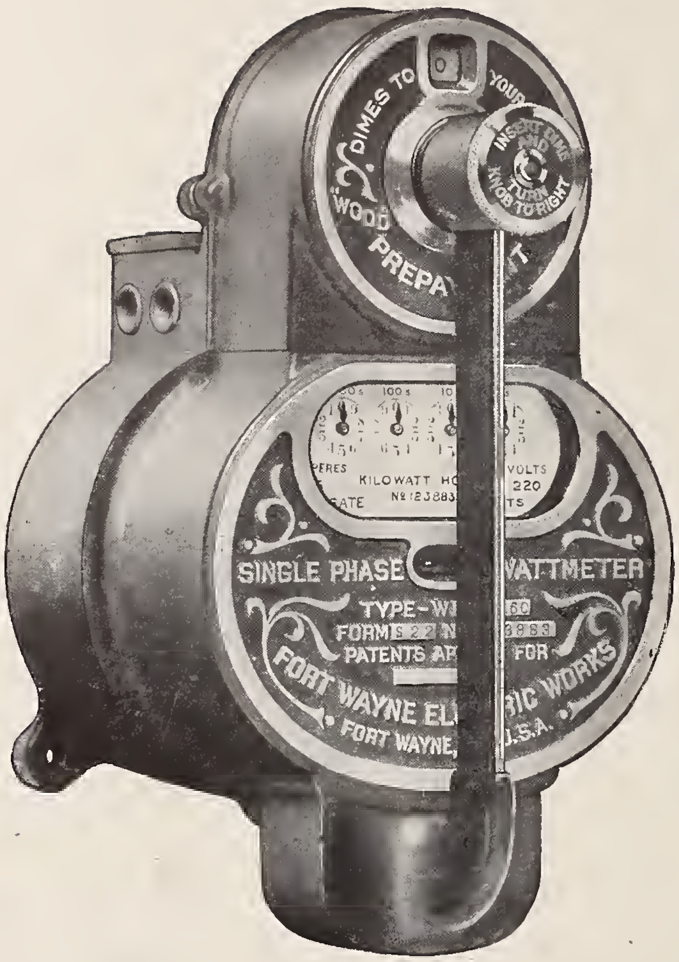


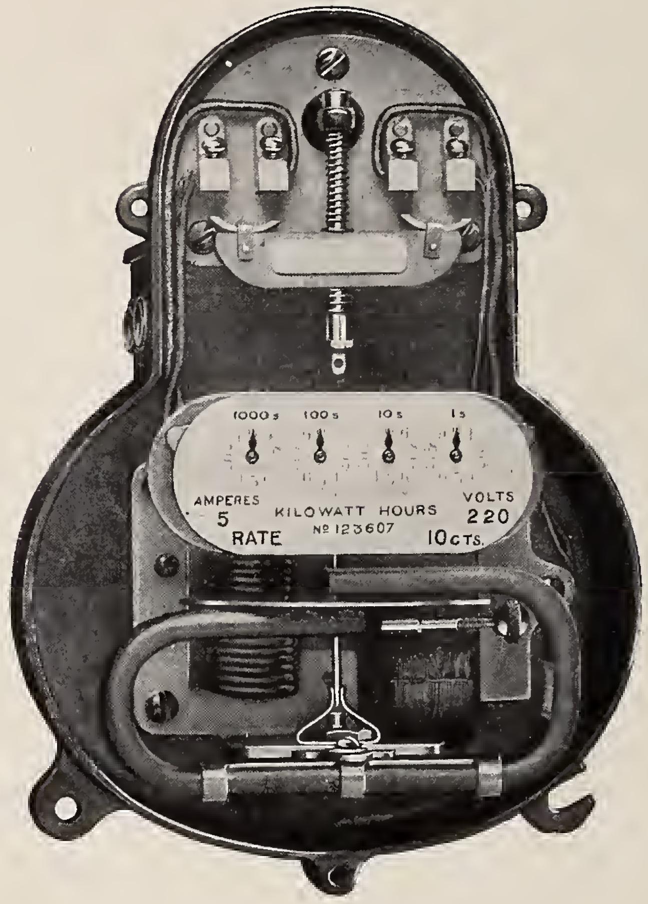
Interior of the Thomson Recording Wattmeter



View of the Small Commutator and Gravity Brushes in the Thomson Recording Wattmeter

ELECTRICAL MEASURING INSTRUMENTS MADE BY THE GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.





EXTERIOR AND INTERIOR VIEWS OF THE PREPAYMENT INDUCTION INTEGRATING WATTMETER MADE BY THE FORT WAYNE ELECTRIC WORKS, FORT WAYNE, IND.

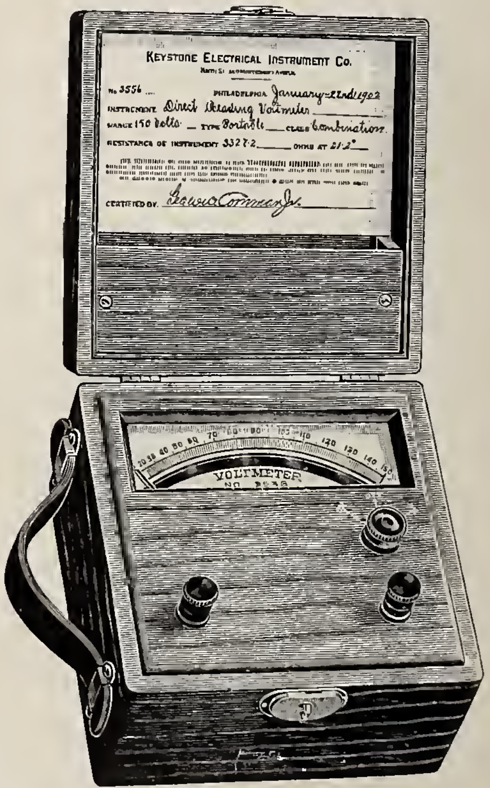
In ammeters of large capacity only the small shunt leads need be brought to the instrument, which means a substantial saving in bus-bar cost and a valuable increase in flexibility.

Some of the more familiar edgewise instruments are now equipped with translucent dials, illuminated from the rear, the lamps being set in a ventilated compartment entirely separate from the working parts of the instrument. The use of aluminium in the moving elements of instruments is now in considerable favour, as is the practice of attaching pole pieces to permanent magnets before they are magnetized and aged, to avoid the disturbance of the magnetic condition during assembly.

In instruments of the electro-dynamometer type,—which depend upon the mutual attraction between two coils through which the current passes, one coil being fixed and the other movable,—it is important that the relation between the fixed and moving coils, and between their inductive and non-inductive resistances, should be carefully worked out in order to eliminate as far as possible the errors due to self-induction and phase displacement. In the voltmeter made by the Keystone Electrical Instrument Company, of Philadelphia, Pa., with 150 volts' range, the actual error due to self-induction has been reduced to 0.018 per cent. for a 133-cycle circuit, and the error is correspondingly less for a higher range or lower frequency. In a Keystone wattmeter the self-induction error in the moving coil on a 150-volt 133-

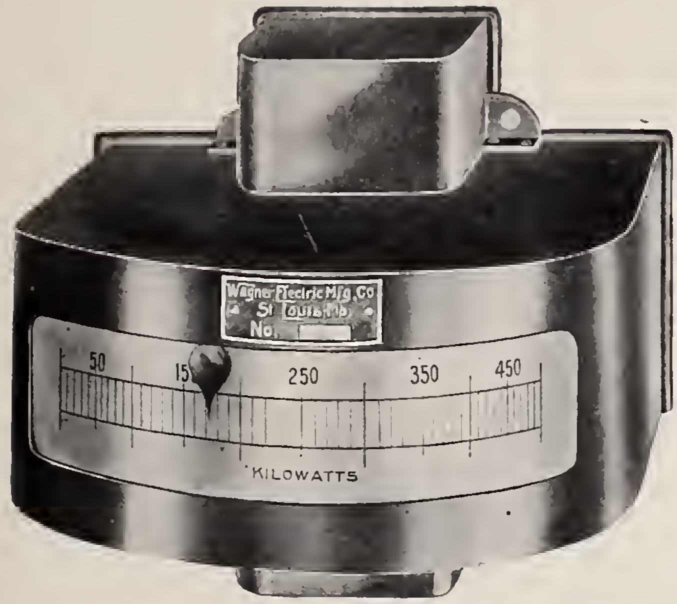
A Direct-Current Switchboard Voltmeter

An Arc Light Voltmeter and Ground Detector



A Portable Voltmeter for Direct and Alternating-Current Circuits

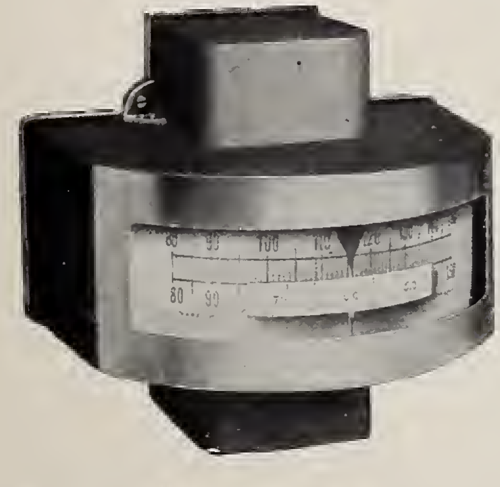
ELECTRICAL MEASURING INSTRUMENTS MADE BY THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, PHILADELPHIA, PA.



A POLYPHASE WATTMETER MADE BY THE WAGNER ELECTRIC MANUFACTURING COMPANY, ST. LOUIS, MO.

cycle circuit is 0.00013 per cent., which is certainly close to a negligible quantity.

The use of bristol-board for scales has been common for a long period, but until recently the custom has been to secure the bristol-board on a flat plate of brass or zinc by means of shellac or some other cement. This arrangement gave rise to trouble from blistering, for it was practically impossible to find a cement which perfectly and permanently secures a semi-impervious substance like bristol-board to an impervious metal. When the bristol-board raises or blisters through the effect of moisture, it is liable to cause the pointer



A WAGNER COMBINED VOLTMETER AND FREQUENCY INDICATOR

to stick or bind on the scale, introducing faulty indications or else shutting down the instrument altogether.

The Keystone Electrical Instrument Company has recently obviated this defect by securing the scale to a perforated metal plate by shellac or other cement. The perforations in the metal permit the cement to come through the plate and form what amounts to numerous flexible rivets which secure the bristol-board rigidly and permanently on the same principle that plaster is keyed to a wall by the use of wooden or metal laths. Experiments prove that such a scale will not warp or blister, nor can it easily be pulled away from its metal backing.

A feature of interest in connection with the design of pointers is the desirability of employing insulated stops to prevent the needle of an instrument from touching the containing case and causing a bending of the pointer or a short circuit if the case is grounded. An interesting practice also in some cases is the use of instruments sunk in the panel of a switchboard, with their fronts projecting only 3 or 4 inches, the lamp behind serving also to illuminate the rear of the board. Such an arrangement is compact and economical, as the lamps may readily be cut out during the day time if the natural light is ample.

Considerable progress has lately been made in the design of commutators for direct-current wattmeters. These were formerly troublesome, on account of brush friction, but improvements in insulation have led to a marked reduction in commutator diameter, and consequently in the friction value. The General Electric Company's type C wattmeter, for example, has a commutator but one-tenth of an inch in diameter, made up of silver bars insulated both from the shaft and from each other. The brushes are equipped with gravity instead of spring adjustment, and with a locking arrangement to prevent disturbance of the adjustment by vibration. The armature is constructed without iron, and there is, consequently, no hysteresis error. To insure lightness, the armature shaft is tubular. The drag disc is of aluminium instead of copper.

The importance of portable instruments has been largely appreciated during the last few years, for the uncertainty of results and the inconvenience caused by the absence of good portable measuring apparatus have been a fruitful source of vexation in the central station field. The manufacturers have realized the situation, and the market to-day presents a remarkably complete assortment of instruments for commercial testing. The best of these are of such shape and size as to be easily handled; the cases are fitted with detachable covers, damping buttons are provided to retain the moving parts in place during transportation, and the exterior finish is very attractive.

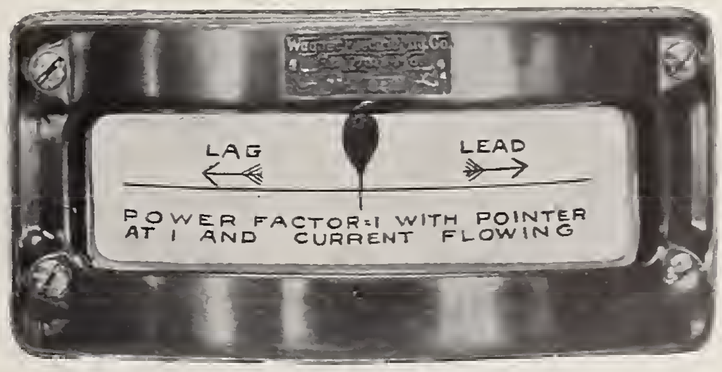
An instrument which illustrates the tendency of the times to concentrate more than one function within a single piece of apparatus is the portable volt-wattmeter made by the Westinghouse Electric & Manufacturing Company. Previously, a lamp inspector's equipment consisted of a lamp testing or other form of wattmeter and a separate voltmeter. The combined instrument just mentioned is equipped with a lamp socket, a volt scale, a watt scale, and two coils which may be cut in or out at the operator's pleasure, according as it is desired to read watts or voltage. A flexible cord terminating in a plug greatly facilitates the testing of lamps in actual service.

The volt-wattmeter can be used equally well on both direct and alternating-current circuits, and is especially useful in office buildings or

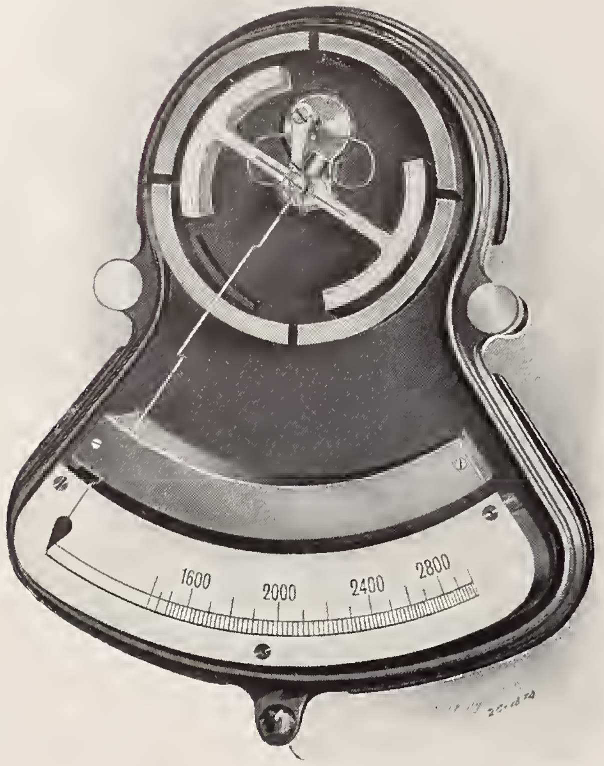
A WAGNER PORTABLE VOLTMETER FOR ALTERNATING AND DIRECT CURRENT

other installations where large numbers of lamps are in constant operation. Another advance in portable instrument design is found in the Westinghouse indicating wattmeter, which measures the true energy of either a single, two, or three-phase circuit under all conditions of unbalancing and low-power factor. This instrument is unaffected by external fields and is therefore specially adapted to motor testing.

A portable polyphase power-factor



A WAGNER POWER FACTOR INDICATOR



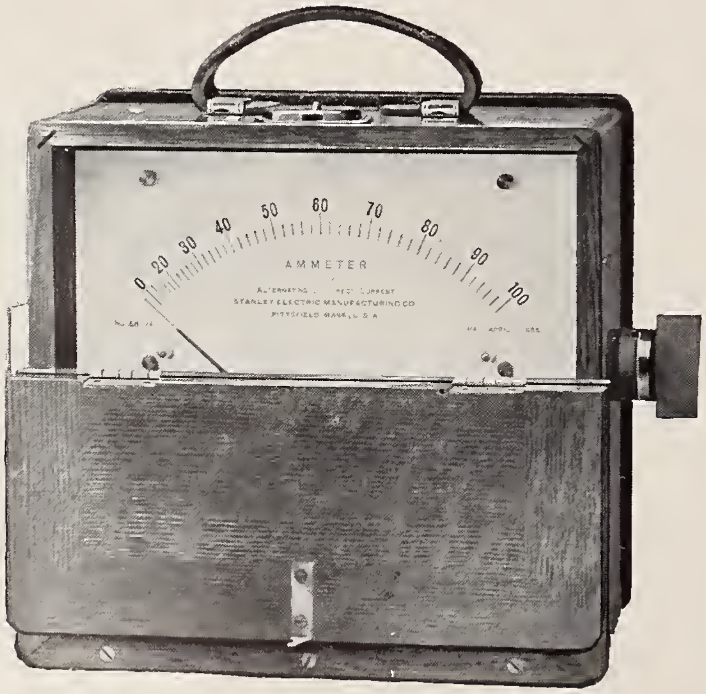
A STATIC VOLTMETER WITHOUT COVER. MADE BY THE STANLEY-G. I. ELECTRIC MANUFACTURING COMPANY, PITTSFIELD, MASS.

meter is also on the market, which eliminates the old method of taking three observations with an ammeter, voltmeter, and one or more wattmeters, and then performing the two calculations necessary to determine the power factor. The old process could not often be carried out in a single group of coincident observations but the new instrument gives by direct reading the result formerly obtained by such labourious methods. In an industrial plant driven by induction motors, the portable power-factor meter throws considerable light upon the conditions under which the motors are being used. These advantages apply also to the use of power-factor indicators in switchboard work, especially where rotary converters or synchronous motors are connected with the circuits. The proper and convenient adjustment of the effect of inductive loads is notably assisted by such apparatus.

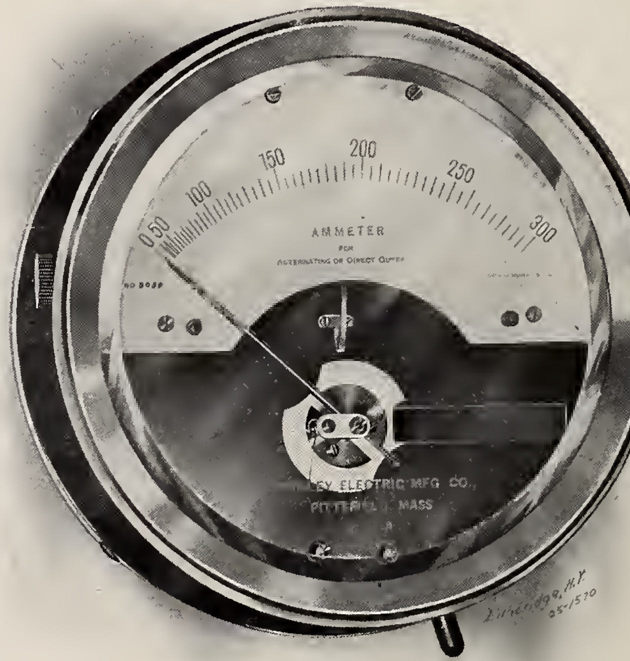
The combined voltmeter and frequency indicator is another valuable addition to the list of instruments now on the market. This instrument as made by the Wagner Electric Manufactur-Company, of St. Louis, Mo., carries two scales, and is calibrated for 10 cycles below and 10 cycles above normal frequency. It will indicate a change in frequency of 0.5 cycles, and is independent of voltage conditions as far as the frequency readings are concerned. In some cases the frequency scale is plotted in revolutions per minute, but this is not desirable unless all the generating units in the plant have the same number of poles. This type of frequency indicator serves to assist the station attendants in maintaining the frequency of the circuit at a constant value, keeping induction motors at the proper speed, and preserving the accuracy of induction wattmeters. It is also useful in paralleling generators, and it eliminates the old and tedious method in which a tachometer must be used.

Central station managers are coming more and more to realize the value of the voltmeter in series arc plants. As yet but few series arc systems are equipped with more than an ammeter, for this instrument largely performs the function corresponding to that performed by the voltmeter in the constant-potential system. It is important, however, to be able to read the load on the series arc system, and the advantages which the arc circuit voltmeter offers in the way of facilitating tests for grounds, are considerable.

The Keystone Electrical Instrument Company has recently brought out a combined arc light voltmeter and ground detector which is useful in indicating the actual voltage of each circuit, the number of lamps burning, and the character of the ground and its resistance. This instrument can be used when the circuit is alive, and thus gives results under working conditions. It has no microphone contacts, is unaffected by external fields, and does away with a large amount of line patroling in the daytime. Portable milli-ammeters for use in testing transformers are now on the market, and where the total current to be measured is small and the circuit resistance or inductance high, tests may readily be made with the secondary on open circuit, thus determining the idle losses of a transformer system without complicated measurements or calculations.



A STANLEY-G. I. PORTABLE AMMETER FOR ALTERNATING OR DIRECT CURRENT



A STANLEY-G. I. HOT-WIRE AMMETER WITH HARD RUBBER CASE

There has recently arisen a strong demand for an indicating ammeter capable of reading with a single scale and a single pointer either the sum of, or the individual currents in, a polyphase circuit. The Wagner Elec-

AN INSPECTOR'S PORTABLE VOLTMETER WITH ADAPTERS. MADE BY THE WESTON ELECTRICAL INSTRUMENT COMPANY, NEWARK, N. J.

tric manufacturing Company has developed an instrument of this kind which is applicable either to two-phase or three-phase machines with balanced or unbalanced loads. It is accurate within 2 per cent. for a balanced load, and within 5 per cent. for an unbalancing of 60 per cent. on either line. In addition to reading the total amperes on the system, readings can be taken to determine how much the system is out of balance, and it is possible with this single instrument to obtain all the information that can be given by three single-phase ammeters,—and this without any intermediate calculation. The saving effected in switchboard space is also considerable.

An interesting class of switchboard and portable instruments is that which the Stanley-G. I. Electric Manufacturing Company, of Pittsfield, Mass., has developed in connection with the hot-wire principle. Such instruments operate independently of magnetic influences, are unaffected by frequency of wave form, and are correct on either alternating or direct-current circuits. As external fields do not influence a hot-wire instrument, it can be installed without regard to bus-bars or heavy cables. Hot-wire ammeters have been made sufficiently sensitive to measure currents as small as 0.25 ampere for full-scale deflection, such instruments being largely used in measuring alternating currents in carbon filaments.

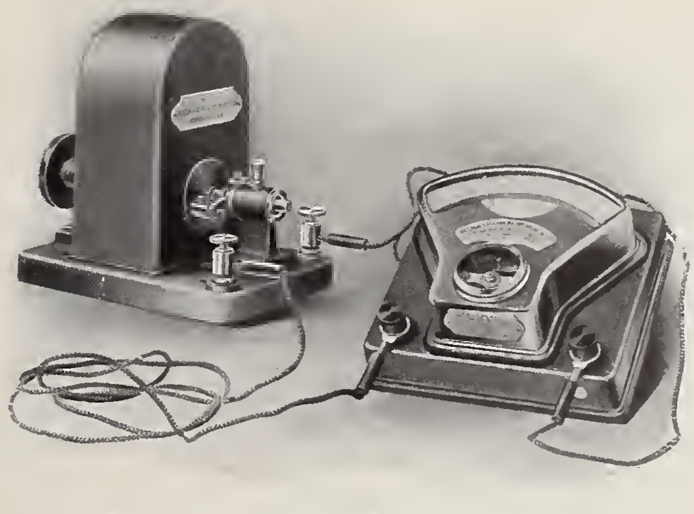
In high-tension plants it is always an advantage and a precaution for the attendants to be able to tell at a glance whether or not the circuits are alive. Electrostatic voltmeters calibrated directly for voltages as high as 30,000, and much above this in special cases, have been in use for several years; the advantages they possess in the way of shielding from external fields of all kinds, their small energy consumption in operation, and the absence of reducing transformers have been widely appreciated. An error of 2 per cent. is the maximum to be expected in this type of instrument, which means an uncertainty of but 600 volts in 30,000.

The testing of consumers' recording wattmeters is one of the most troublesome problems in central station service. Its importance is self-evident, for in many cities practically every dollar that the central stations earn is registered through meter readings. The long accepted method of making such tests was by the use of indicating instruments. Indicating instruments, however, are not always of the degree of accuracy which inspires confidence in the results. In many cases the standard portables are inferior to the service meters, which latter usually have a high degree of precision at all loads. Integrating wattmeters have often been condemned when the fault was in the errors introduced by the low part of the scales of the indicating instruments used in testing. The inconvenience of carrying about several different ranges of instruments has also been considerable. To overcome these defects, a comparatively new line of precision instruments with extremely long ranges has been developed by the Westinghouse Electric & Manufacturing Company. Verniers are provided to facilitate accurate readings, which can be taken even with very small deflections. The ball-and-cup jewel is used for supporting the moving element, as in the integrating wattmeter made by the same company. The General Electric Company has also recognized the increasing importance of the meter-testing question and has brought out a high-torque induction test meter of the integrating type with which very rapid and accurate tests can be made at the point of installation. With this apparatus a single standard can be used to check meters of different capacities, covering a range of from light load to full load. Personal errors of observation are practically eliminated, no stop watch is required, and the cupped diamond bearing has been used to reduce the effect of friction to the lowest possible amount. The meter possesses the same accuracy throughout a range of 200 to 1, and the errors due to 10 per cent. changes in voltage or frequency are negligible.

A WESTON PORTABLE VOLT-AMMETER WITH CASE

It is impossible in the space of a single article to do justice to all the excellent instruments now on the market which illustrate recent progress in apparatus for electrical measurements, but the writer trusts that the foregoing comments will at least show that constant advance is being made in this interesting and important field.

The induction wattmeter built by the Fort Wayne Electric Works, of Fort Wayne, Ind., also deserves mention as a representative modern instrument. Owing to the compact and symmetrical arrangement of the working parts, the meter occupies a space of but 382 cubic inches, and can be installed in quarters measuring $6\frac{3}{4}$ inches by $8\frac{7}{8}$ by $6\frac{3}{8}$ inches. The instrument weighs only 13 pounds, the case being of cast aluminium. Aluminium is also used in the construction of the armature, which is of the cup type. The lower bearing consists of a mounted jewel enclosed in a special screw which is adjustable vertically. The jewel rests on a coiled spring within the



A WESTON SPEED INDICATOR OR MAGNETO-ELECTRIC TACHOMETER

jewel screw, which supports the rotating parts flexibly and prevents wear that might be caused by shocks or vibration. The jewel screw can be raised or lowered after the proper adjustment is made. The shaft is of steel, with the bearing end accurately ground to a microscopic finish, and the jewels are Oriental sapphire. An interesting feature of the gear design to reduce friction is found in the cutting of the gears and worm as accurately as in the case of watch gears, with a microscopic finish and inspection.

The permanent magnet is held in an upright position in the Fort Wayne meter, as distinguished from the usual horizontal arrangement. It is adjustable vertically for varying the drag on the aluminium armature, and its upright position and distance from the series coils present magnetic disturbances in case excessive currents flow in the latter during heavy overloads. The jewel bearings in these meters are all of the same design and are easily removed; as the shaft and jewel are the only parts subject to depreciation with long service, it is possible for a central station to thoroughly overhaul and repair the meter at an extremely low cost without affecting its calibration. Contrary to the more general practice of employing constants in obtaining the actual meter reading, the Fort Wayne dials are made direct reading. The dial plates are made of a dull-finished porcelain to eliminate any reflection tending to obscure them. An adjustment is also provided so that each meter can be used on either a 60-cycle or 133-cycle circuit, at the pleasure of the user.

The "Wood" voltmeters and ammeters constructed by the Fort Wayne Electric Works are built entirely without springs or permanent magnets, and the moving parts are light and mounted in sapphire jewel bearings. The scales are long and open, and are graduated evenly and with distinctness on brass, silver plated. The company feels that the metal scale plate is much more satisfactory than cardboard or paper scales, on account of greater durability. Gravity alone is used in balancing the actuating forces, and the instruments may be left permanently in circuit without danger of injurious heating or impairment of accuracy.

A new Japanese electric trolley line, the first to connect two large cities in Japan, was recently opened, to compete with the steam road between Kobe and Osaka.

The Father of the Trolley

A Biographical Sketch of Charles J. Van Depoele

By DUGALD McKILLOP

SKETCHES of a man so identified with many phases of the electric art as the late Charles J. Van Depoele have, of course, been freely published, but in a couple of decades some things are forgotten, and many new students come on the scene. Even fame is relative, however, and a sketch of any electrician that is fulsome is also foolish, for of all things, real biography involves the nicest balancing.

A HITHERTO UNPUBLISHED PORTRAIT OF CHARLES J. VAN DEPOELE

To achieve eminence in any line of human attainment there must be genius back of it. Notoriety is not fame; the sensationally notable of today may be eclipsed by the yardstick headlines accorded to to-morrow's fickle favourite. One may become notorious, and even popular, through some act or quality that catches the public fancy; but fame is the encrownment of a person of attainment with the fadeless laurel that comes as a tribute from that conserving body of workers whose collective wisdom is its glory. Probably we may be complacent over the fact that the lay mind will continue to regard the subject of this sketch as "The Inventor of the Trolley."

Prominent and great men, living or dead, are, to some degree, public property. But large as is the electrical business, it is only a specialty in the great world, and the general reader may be glad to grasp the salient features of electrical biography in such a way as a well-read electrician might wish to see the deeds of the men of an alien calling epitomized. That great intelligent outside clientele may agree that American electricians should be grouped according to one or two of their well defined, though not necessarily their greatest, achievements.

One may be called the wizard of the incandescent lamp, and another of the arc, while the first wizard aforesaid may have the multiplex telegraph and phonograph to buttress his secure name in the electrician's hall of fame. Electric welding may not be the greatest contribution of another inventor to the advancement of the art electrical, but to the ordinary student it will be apt to stand

out with prominence. Just as the skillful artist knows the value of sharp contrasts of light and shade, so the student of the deeds of inventors in the American electrical field will recognize that the public mind naturally fastens upon strategic points, whether it be the phonograph of Edison, the polyphase system of Tesla, the trolley of Van Depoele, the welder of Thomson, or the arc lamp of Brush.

Charles Joseph Van Depoele was born April 27, 1846, at Lichtervelde, Belgium. He began the study of electricity in his very boyhood, and when telegraph lines were first erected in his home town he secured his initial training in the art in which he was destined to become famous. His father, Peter Van Depoele, was for several years master of the East Flanders shops at Poperinghe. The lad had access to batteries and other electrical apparatus of the railroad connecting Bruges and Poperinghe. Bruges is the capital of West Flanders, and in 1810, Napoleon, then in the height of his glory, decided to connect it with the sea by means of a canal.

With his spare money the youth bought such books on physics, natural philosophy, and electricity as were procurable, and with his own hands constructed electromagnets and batteries. He attended the College of Poperinghe, but was far ahead of his classes in his favourite line of study and experiment. So great was his ardour that he burned much midnight oil in studies that tended to discredit oil as an illuminant; and it is with satisfaction we note that when but fifteen years of age, and still at school, he succeeded, by means of some forty Bunsen cells, in producing his first electric light.

The elder Van Depoele did not appreciate his boy's electrical efforts and experiments, and oftentimes the crude apparatus was hidden from the parental eye. When sixteen years of age, Charles was apprenticed to a church furniture and fancy woodcarver in Paris. The family about this time removed from Belgium to Lille, France, and the young man took as thorough a course in electrical studies as was afforded by the Imperial Lyceum. Carrying an ardent spirit of investigation to the new location, the work of the young man soon attracted the notice of Dr. Patoir and others.

In 1868 a spirit of roving seized the young man, and, to save any troublesome questions, he ran away from home and spent two weeks with his aunt at Antwerp, before sailing for the United States. He located in Detroit, Mich., where he was later joined by the parents he had deserted, and in 1870 married Miss Mina A. Van Hoagstraten.

The value of a trade in which he was expert was demonstrated, and Van Depoele, with Joseph Artz, another Belgian, started a church furniture manufactory. For this purpose, a Methodist church in Pine street, Detroit, was purchased, and as many as 200 hands were employed at one time. Ever fertile in resources, Mr. Van Depoele converted the rear part of the church into a residence. The business of making altars, pulpits, etc., was carried on till 1877, when, turning the factory over to his father, he entered the electrical field.

During the next twenty years the career of Van Depoele was that of the typical inventor who attempts to enter the commercial world at a time when he has not only to supply the technical ideas, but also to create the demand for their exploitation. After the first ten years of persistent effort, however, the obstacles lessened, and when, in 1879, he had lighted up the great tent of the Adam Forepaugh Circus, the Detroit Opera House, and other places, public interest was aroused, and, now that a sure thing was in sight, capital came out of hiding.

Van Depoele having, as stated, turned over his wood-carving business to his father, built a shop where he conducted his enlarging experiments. Apparent success in the lighting experiments inspired confidence in other schemes of the same inventor. Though the electric lighting problem engrossed the greater part of his attention from 1870 to 1879, yet the genius of the inventor flashed out in many directions. Besides experimenting with many kinds of lamps, not less than fifteen types of dynamos were experimented with, many combinations being tried and windings made. About 1880, new shops in Hamtrack were taken, several new machines built, and a Detroit company was formed to build electric machinery. Removal to Chicago came soon after. The vigour of the Van Depoele concern in the electric railway field, from 1882 to 1887, is demonstrated by the fact that in the latter year thirteen electric railways were in successful operation in this country. Early in 1888 two more roads were completed. Montgomery, Ala., has the honour of being the scene of the first Van Depoele road whose success attracted general attention. The year 1887 marked an era in railway traction, as up to that time cables, horses, and mules had been the staples in street car propulsion. In those days grave questions of glanders, horse-shoeing, stables, and care of horses were debated in the gatherings of street railway men; indeed, as late as 1889, the leading paper for discussion at the American Street Railway convention was one entitled "A Perfect Street Railway Horse." That convention was held at Buffalo, N. Y.

The under-running trolley had its first real success on a considerable scale on the Montgomery road in the summer of 1886. Of this equipment E. M. Bentley says:—"These two cars were operated for nearly 2 miles on Court street, and by reason of their success, the Van Depoele Company was in September, 1886, given a contract to equip the entire street railway system of the city. In May, 1887, the road was opened for public business. The lines equipped included between 12 and 14 miles of track, with numerous curves and switches, and operated fourteen cars. The trolley pole was placed near the forward end, and, as the road was operated with loops or turntables, the cars and trolleys were not reversible. The overhead trolley wire was sup-

ON THE FIRST ELECTRIC LINE AT STREATOR, ILL. FROM A PAINTING OF 1883

VAN DEPOELE AND SOME OF HIS EARLY ELECTRIC LIGHT AND RAILWAY ASSOCIATES. THE GROUP COMPRISES FRANKLAND JANNUS, JOHN COOK, JOHN VAN HOOGSTRATE, JAS. McLAUGHLIN, GEN. STILES, C. J. VAN DEPOELE, FRANK SHEAL, ALBERT WAHL AND ELMER P. MORRIS

ported as in modern systems by cross-wires, which in some places were anchored to the buildings on either side." This installation in the South was notable chiefly because of its use of the under-running trolley (in essentials similar to the trolley of to-day), and to the fact that the central station was equipped with two generators of 250 H. P. each,—then considered large units.

Apparently, Van Depoele, though a pioneer with several others in railway motor work, was the pioneer of trolley apparatus that has endured. There are several links between the horse-drawn car of a decade ago and the palace electric passenger car of to-day. The survival of the Van Depoele idea of the little wheel on the trolley pole, running under the overhead wire in place of the single or double over-running trolley of the early experiments, or any other subsequent form, is a rare instance of mechanical fortune.

Another fortuitous experiment that had a sweeping effect in electric traction schemes was the substitution of carbon brushes for metallic brushes. The use of copper brushes on car motors, subject to reversals in direction of rotation and to overloads, was such a constant source of annoyance that it is doubtful if railway motors under such conditions would ever have attained commercial success. Van Depoele came to the rescue with a suggestion, at first tried with slight hope, but which soon became recognized as of immense value. The necessary shifting with copper brushes is unnecessary with carbon brushes, and the yoke can be fixed in one position, thus insuring a good glaze on the commutator. Within two months after the first trials of the carbon brush, many railway lines were reporting excellent results with its use.

The inception of the carbon brush came in the fall of 1888. It was in March of the same year that the Van Depoele electric railway business was acquired by the Thomson-Houston Electric Company, of Boston, and the closing years of Mr. Van Depoele's life were spent in the shops of that company, at West Lynn, Mass.

No history of electrical development to be written can afford not to accord a generous and commanding place to Van Depoele, both as an idealist and as a potent result-worker. No special plea for a due recognition of his labours is needed, nor could there be any lasting eclipse of the glory of the great pioneer who had operated railways in a dozen different cities before his competitors had arrived at a sound theoretical basis for their experiments. If results count, then the early railway work of Van Depoele would seem to warrant our styling him the notably successful pioneer in electric traction. Hearty recognition in this direction has often been given. For example, Gen. Eugene Griffin calls him a great inventor, and adds:—

"The courts have repeatedly held

that Van Depoele was a pioneer in the railway art, and his patents have been sustained by the Federal courts in all parts of the country. We owe to Van Depoele the carbon brush, without which the electric railway motor and, I might even say, the direct-current dynamo, would have been a comparative failure. We owe to Van Depoele the under-running trolley, which was an essential of the early roads and is an essential to-day."

Van Depoele died on March 17, 1892, and was buried at St. Mary's Cemetery in Lynn, Mass. At the time of his death, the inventor was developing an electric lighting apparatus which he claimed would outclass anything he ever produced, both as an invention and as a money-maker for himself. Although he had vast hopes of this discovery or invention, and often referred to it in general terms to intimate friends, yet the secret died with him. An attack of measles, following pneumonia, was the immediate cause of the death of this man of vigourous frame, fertile intellect, and generous disposition.

A recent writer in referring to the growth of the Westinghouse electrical interests, has used the expression,—"They are now appalling in their size and extent." What more appropriate words could be used in regard to the general electrical expansion of to-day? Without the ability of Van Depoele, exerted in this field from 1882 to the time of his death, where would the electric traction, power, and lighting interests have been? At what point of arrested development would they have tarried?

It may be said that if one engineer had not invented such things as the carbon brush, the electric drill, and the trolley, others would have done the necessary hard thinking, experimenting, and exploiting. Such reasoning is more cogent when applied to completed discoveries than to the tantalizing needs of invention that even to-day exist so plentifully. Charles J. Van Depoele was at least a prominent factor among the pioneers of electric lighting and railroading, and it may be conceded that the pupils in the High School of Lynn are properly instructed when they are taught—as they sometimes are—that the inventor of the trolley a few years ago resided on Essex street, near the school building of to-day.

Nearly 250 United States patents were granted to Van Depoele in about fifteen years of active electrical work. These patents cover almost every phase of electrical applications. The vast versatility and industry of the inventor during this period, often under depressing circumstances, may be somewhat realized by these figures, as even a digest of these patents would make a formidable volume.

The genial social qualities of Mr. Van Depoele are enshrined in the hearts of many, and in appreciation of his personality and work, the beautiful public library building of Lynn contains a bronze bust of the electrician, made by the late R. Kraus, of Boston. And even should his many-sided achievements be unrealized or overlooked by coming generations, it seems probable that one title will cling, viz.,—"The Father of the Trolley."

Mention may be made of the illustrations, all hitherto unpublished. The single portrait will be conceded by those who knew Mr. Van Depoele as superior to any other in existence. The cut of the car shows part of the first electric line at Streator, Ill., and is taken from a small picture, painted in 1883, now in possession of Mrs. Van Depoele, of Lynn, Mass.

The third picture, showing a group of associates in the early days of electric light and railway projects, is self-explanatory. It was taken in Chicago in 1888, during the progress of some litigation that brought together a number of men of some prominence in the business at that time, and subsequently.

The Cunard Steamship Company have already five of their North Atlantic steamers fitted with the submarine signalling apparatus, and the "Carmania," the largest turbine driven steam in the world, and the first to run between Europe and the United States, will also be equipped in this way. Trials have been made on board the Hamburg-American Line steamer "Deutschland," from which the bell at the Outer Weser lightship was located at a distance of 5 nautical miles, while the noise made by the propeller of a large passing steamer was distinctly heard at a distance of 1½ miles, though the "Deutschland" was steaming 19 knots.

In a paper read before the American Street Railway Association, Arthur West states that one of the objections against two-cycle gas engines is their low mechanical efficiency, which often does not exceed 60 per cent., while four-cycle engines may have a mechanical efficiency of 85 per cent.

Electrical Toys for Christmas

FEW realize to what extent electrical toys enter into the Christmas trade. At the present time a toy is out of date unless it is capable of performing some extraordinary feat, and for this purpose electricity is particularly well adapted. There are few shops in the large cities which handle a representative class of Christmas goods that do not have some space devoted to electrical toys, but, as a rule, the clerks in charge are inexperienced, and often do not possess sufficient knowledge of electricity to either properly promote the sale of these goods or furnish correct information on their care and usage. Notwithstanding this fact, many electrical toys are sold, at prices ranging from a few cents to hundreds of dollars each.

Of the better class of such toys may be mentioned theaters and doll-houses, lighted by electricity and completely equipped with telephone service. These sell for $200. Another elaborate electrical toy is a miniature electric railway, comprising tracks, cars, and electric locomotive. The stations, especially those at each terminus of the system, are of generous proportions and are attractively decorated. The switches are operated by a system of automatic signals. There also are diminutive safety bumpers for use in the car yards. The system is designed to be operated by direct current of from 100 to 250 volts pressure.

According to "Elektrische Bahnen," a 12-mile single-phase railway has recently been put in operation in the Borinage district, which is the southern coal region of Belgium. The total length now equipped with the single-phase system is 12 miles, but this will be extended to 77 miles, which will be supplied from one point with single-phase current at 6600 volts. For the lines equipped at present, the voltage is reduced in transformers along the line to 600 volts, while for further extensions a higher voltage will be employed on the trolley wire, in order to reduce the number of transformers needed.

In a British court recently a cabman gave as the reason for his inability to pay his debts that "it's electricity everywhere now. Electric cars, electric trams, electric 'buses, electric cabs, in fact, electric everything."

Artificial Illumination—VII

By DR. EDWIN JAMES HOUSTON

Continued from the November Number

SHOW-WINDOW ILLUMINATION

PERHAPS one of the least understood directions in which artificial illumination is employed is for the proper display of goods in the windows of stores. Here the object is to bring out clearly the forms and outlines of the goods, and especially to display them in their true colours. For this latter reason the daylight values of the illuminants must be carefully taken into consideration.

The most important requirement in order to insure the best effects in show-window illumination is that no light whatever shall be permitted to enter the eye of the observer directly from the luminous source. All light seen by the observer should be strictly limited to that which is diffused or radiated from the surface of the illumined objects; in other words, the light employed for the illumination should be permitted to fall on the surface of the objects to be illumined, and from them enter the eye of the observer. Here the conditions required for good illumination refer especially:—

1. To the amount of the illumination.
2. To the steadiness of the light.
3. To the approach of the luminous rays to ordinary daylight values.

It will be noticed that the requirements as regards the protection of the eyes of the observer from the direct light of the luminous source are the same as those required to produce the best results in ordinary machine shop lighting, where the light entering the observer's eye is limited to that which comes from the work. As, too, in the case of machine shop lighting, regular reflection of light is to be carefully avoided, since all such light which enters the observer's eyes is not only useless for the purposes of ordinary vision, but seriously interferes with it.

The lighting of a show window differs from the lighting of an ordinary room:—

1. As regards the position of the observer.
2. As regards the fact that one of the surfaces of the show window consists of a highly reflecting transparent substance like glass, while the material which forms the background and sides may be some non-transparent, partially absorbent coloured material. As will be seen, the character of the background of a show window has a marked effect on the efficiency of this character of illumination, and this to a great extent independently of the position in which the luminous sources are placed.

In the days of the coal oil lamp or the gas jet, the position of the luminous source was necessarily fixed by the uncovered nature of the flame and the highly combustible nature of the materials surrounding the luminous source. These peculiarities resulted in the limitation of the position of the source either to some point near the middle of the window, or at least at a fairly considerable distance from the top of the window or from either side. Consequently, effective show-window illumination was extremely difficult to obtain, owing to this forced position of the light. With, however, the advent of the incandescent electric lamp, the fact that the lamp bulb is enclosed, and can be placed close to the wall or ceiling, or to highly inflammable goods, without danger of starting fires by the ignition of the surrounding material, the problem of effective show-window illumination has been greatly simplified.

The most important consideration which must be carefully borne in mind in order to insure the best effects from the artificial illumination of show windows is that the sources of light must be concealed from the observer. This is only another way of saying that the light from the illuminant must not directly enter the observer's eyes.

Probably one of the most inefficient methods of show-window illumination consists in placing an open arc light somewhere near the middle of the window. Such a method of illumination would be admirable if the object to be displayed were the lamp itself, and if the ability to see the objects on which its light fell was a matter of indifference. An arc lamp, placed anywhere in sight in the comparatively limited space enclosed in an ordinary show window, must necessarily be to an observer on the outside, not only the most conspicuous, but practically the only clearly discernible object in the window. It is true that in the far corners or nooks of the window some articles may be fairly well seen, provided the observer studiously avoids glancing even momentarily at the lamp, but probably in ninety-nine cases out of one hundred, the bright light will first attract the observer, and will not only markedly decrease the sensitiveness of the retina for distinct vision, but will produce an automatic contraction of the pupil of the eye which will markedly decrease the amount of light which the eye can utilize for the purposes of vision.

It is to many people a matter of surprise that when a light so bright as that from an ordinary arc lamp, especially when of the open arc type, is placed, say, in the middle of a show window filled with goods of various colours, that so few of the details of the goods themselves are visible; for, since the arc lamp throws out light with equal intensity in practically all directions, it would seem as if such objects should be clearly seen. They cannot be clearly seen, however, owing to the physiological effects of the strong light entering the observer's eyes. If any proof is wanted of this assertion, let one notice a case in which an arc light is suspended in front of a sign in the street, and it will be found that from most positions the lettering on such a sign is practically invisible.

An illustration of the fact just referred to can be seen in many cases of flashing incandescent lamp signs. I have recently noticed a sign of this character placed on the front wall of a building covered with an ordinary painted sign intended for use by daylight. The general illumination of the street at night was sufficient to show the ordinary sign with sufficient distinctness to permit the letters to be read, but whenever the lights would flash out on the electric sign, the letters and words on the ordinary painted sign would instantly become invisible, only to reappear as soon as the electric light was automatically extinguished.

There are degrees of inefficiency in the lighting of a show window by an arc lamp, the objections becoming less marked the greater the distance the arc light is placed above the goods in the window. Of course, this increased efficiency is due to the fact that the greater the distance of the arc lamp above the bottom of the window the less is the light which is apt to fall directly in the observer's eyes, and the less the probability of the observer glancing directly at the light. When an arc lamp is placed in such a window and provided with a screen so as to absolutely cut off the light from the observer's eyes, a fairly efficient illumination of the objects in the window may be obtained. Owing to the fact that the daylight or colour values of an arc lamp can be made to closely approach those of ordinary daylight, when properly distributed, an arc lamp can be employed satisfactorily for the lighting of show windows. In the case of long arcs, however, the tendency to produce a large proportion of the blue rays makes this light much less satisfactory than it would otherwise be for bringing out the true colours of fabrics. By the use of the enclosed arc light, where the inner globe is made of opalescent glass, a large proportion of the blue rays are absorbed, and the resulting colour then more nearly approaches that of daylight. There are, however, other difficulties attending the use of arc lamps for show-window illumination that will be referred to subsequently in this article.

Perhaps the most satisfactory effects for show-window illumination are obtained from the use of high candle-power incandescent electric lamps. If the voltage at which the incandescent lamps are operated bears such a proportion to the resistance of the filaments that the temperature is comparatively low, or, in other words, if the lamps are working at a low efficiency, the preponderance of the orange and red rays over the other colours of the spectrum makes the light unsatisfactory, but if the lamps are working at a high efficiency, and the proper precautions are taken to obtain a uniform distribution of the light, the colour values are fairly satisfactory.

The most important consideration respecting the proper illumination of show windows is the position of the lamps. A walk through the streets of any large city at the present time will show an extremely varied practice in this respect when incandescent lamps are employed as the artificial illuminant. A very common plan, especially where the holophane or similar globes are employed, is to place the lamps either on brackets, or on drops, or even in large electroliers directly in the window. This method, while perhaps less objectionable than the placing of an arc lamp near the middle of the window, is nevertheless highly unsatisfactory, since it results in making the source of illumination the most prominent object in the window, whereas, in point of fact, it should be invisible, since to the extent that it is visible, to that extent does its light enter the eye of the observer directly.

Another method of show-window lighting by incandescent electric lamps, which is even more objectionable than that of placing the lamps in sight on brackets, or in an electrolier, consists in distributing a great number of lamps in plain view from the top or sides of the window. Here, while the objects in the window are well illumined, yet a disagreeable reflection of the light will be made from the glass of the window, and a considerable proportion of the light must, in many cases, enter the eye of the observer directly. Moreover, should the observer inadvertently glance at the top or sides of the window, his ability to see distinctly for a short time afterward will be markedly decreased.

But any use of a bare or uncovered source of light, whether it be an arc light or an incandescent light, must almost necessarily fail to afford that uniformity of illumination which is necessary in order to insure the most satisfactory results, unless, indeed, the number of luminous sources is comparatively great. In other words, no method of direct illumination can be expected to be successful for show-window illumination. Consequently, some method of indirect illumination must be employed in its stead.

The indirect illumination required for the proper lighting of a show window may be obtained:—

1. By the use of suitable reflectors.
2. By the use of suitable diffusers.
3. By placing the lamp itself in a globe of ground glass or of translucent porcelain, so that the entire surface of the globe becomes luminous.

As has already been pointed out in the first article of this series, there is a marked difference between the effects produced as regards illumination by regularly reflected light and those insured by the irregular reflection of light, commonly known as diffusion. The reason of this is to be found in the fact that every illumined point throws its light in all directions, so that a single lamp placed back of a diffusing shade is practically divided into a great number of luminous sources. By using a suitable number of such shaded lamps, it is evident that the existence of shadows will, to a great extent, be avoided.

It is a fortunate circumstance as regards the proper lighting of show windows that the source of light had best be kept out of view, for, under these circumstances, there is no objection to the use of opaque shades, the surfaces of which, lying next to the source of light, are covered with a substance possessing high diffusive powers, such as aluminium paint. Indeed, generally speaking, the best effects are to be obtained by luminous sources of this character.

Another highly objectionable method of using incandescent lamps for show-window illumination is that in which a number of lamps are placed directly on the bottom or floor of the show window. Here, as is evident, it is impossible to prevent their light from directly entering the eye. For the same reason, the method of surrounding the sides and top of the show window by a line of bare, uncovered lights is also highly objectionable.

Having pointed out the methods that are to be avoided as regards the location of the lamps, let us now consider the locations which will insure the best results. These locations, named in the inverse order of their efficiencies, are:—

1. Where the lamps are placed in vertical rows on the sides of the window, back of some opaque material which will prevent the lamps from being seen, but which is covered on the side next to the luminous source with a coating or covering of aluminium paint or some other good difusing substance which will result in throwing or scattering the light in all directions on the objects in the window. This method is capable of producing satisfactory results.

2. Placing the lights near the top of the window, and yet hiding them entirely from view by the use of some suitable material. The material employed for this purpose may be either opaque or partially transparent. If such material is not too transparent, the amount of light which comes through is not at all injurious, and since this light can be employed for the purpose of illumining a translucent or semi-transparent screen, very satisfactory effects can be obtained in this way, since the person looking in the window can comfortably see either the proprietor's name or some reference to the character of the goods which the window contains.

Of these two methods, i. e., illumination by vertical rows of concealed lamps placed on the sides of the window, or by horizontal rows of concealed lamps placed on the top of the window, the latter is apt to afford the more uniform, and, consequently, the more satisfactory illumination, especially where the windows are large, since by the use of the former method the general illumination is marked by a lack of uniformity, being much greater near the sides of the window than near the middle. In the latter method, instead of employing a single row of incandescent lamps at the top of the window, the entire ceiling of the window may be covered with parallel rows of lamps.

The character of the background is a matter of considerable importance in obtaining the most satisfactory results in show-window illumination. It is practically impossible to lay down any general rule as to what the character of the background should be, except that, generally speaking, it is preferable not to employ a background the colour and surface of which will absorb too large a proportion of the light. In order, however, to insure the necessary degree of sharpness as regards visibility of the goods, a certain contrast should exist between the background and the goods themselves; for example, if the goods that are being displayed are black, such as evening clothes, a light-coloured background is preferable. On the contrary, if the objects consist of white shirts, a dark-coloured background is preferable.

It should be borne in mind that where the amount of light available for the illumination of a show window is small, it is a matter of necessity to employ as the background, i. e., the material which covers the back of the window or the bottom and sides of the window, some material possessing the power of diffusing the light or throwing it on surrounding objects. Indeed, generally speaking, no matter what the quantity of light available for illumination, some diffusion should be insured from the background in order to obtain the most uniform illumination. But where it is necessary, in order to obtain the best results, to employ a dark background which is able to add very little light by diffusion, the amount of light furnished by the luminous source should be greatly in excess of that employed where a more highly diffusive background is used.

It should not be forgotten that in the distribution of light for show windows, every effort is made to insure the best results to the eye of an observer who is examining the window from the outside. Generally speaking, however, there is no desire to have such windows observed from the inside, so that this is not a matter of great importance. Where, however, it is desired that an equally clear view be obtained both from without and within the store, an effort must be made to prevent the sources of light from being seen, no matter where the position of the observer be. There always will exist, however, a difficulty in obtaining as satisfactory results from the illumination of a show window when examined from within, owing to the fact that the glass of the window acting as a mirror will produce an image of the lights no matter where they be placed.

It is not entirely the quantity of light that determines successful show-window illumination; such illumination also depends upon the distribution of the light. Of course, a certain amount of light is necessary, this amount depending not only on the size of the window, but also on the character of the background, the colour of the objects, and the nature of their surfaces for absorbing or radiating the light; but within these limits it is practically the distribution of the light that determines the success or failure of the illumination.

It might be supposed that the total quantity of light would alone determine the character of the illumination, but it must not be forgotten, as has already been explained in the preceding articles of this series, that an excess of light produces two effects on the human eye which prevent good vision, i. e., in acting on the colouring matter or pigment of the retina so as to decrease its sensibility, and in contracting the pupil of the eye. If, therefore, the amount of light is sufficient to bring out clearly the details of the objects, the retina of the eye retains its sensitive condition, and the pupil of the eye permits a comparatively large proportion of the light to pass through it, thus insuring the best conditions of vision and consequently of comfort to the observer.

I noted an excellent illustration of these principles in a small store where two bare fish-tail gas burners were suspended from a fixture attached to the ceiling. The fixture was placed at about the middle of the space between the top and bottom of the window, which, being of small dimensions, brought the lights very nearly in the line of vision. The result was that the objects in the window presented a dingy appearance and were very poorly illumined, so that it was difficult to thoroughly distinguish their peculiarities. In an adjoining shop with precisely the same size of window, were suspended two gas lights of the same size and make, apparently burning gas under the same pressure as in the first shop. Here, however, the jets were surrounded by globes of ground glass, and a curtain was drawn down over the top of the window so as to completely cut off the direct light from without. Although in this window the amount of light which reached the goods was necessarily smaller than in the first window, since a certain amount was lost by absorption through the globes, yet the distribution of the light was so intelligently obtained that the effect on the illumination of the objects in the window was really of an excellent character. This case is full of significance as regards the advantages to be derived from some of the principles in the preceding paragraphs. Briefly recapitulating, these principles are:—

1. That the efficiency of the illumination depends not so much on the quantity of light as it does on its distribution.

2. That in order to insure the best results, the eye of the observer should be carefully shielded from all direct light from the luminous source.

3. That the colour of the background as compared with the colour of the goods placed in the window should be such as to permit the goods to stand out sharply against the background, and not imperceptibly merge with such background.

4. That the character of the background as regards its absorptive and emissive power be such as to insure the proper contrast between it and the goods, and wherever possible to add by diffusion to the amount of light available for the illumination of such goods.

5. The general character of the goods that are placed for display in the window.

6. The colour values of the artificial sources of light as regards daylight colour values.

Coming now to the practical side of show-window illumination, in order to test the correctness of the principles given in the preceding paragraphs let us examine somewhat in detail some of the methods actually adopted for this kind of illumination. Purely as a matter of convenience, I will describe some of the different methods of show-window illumination I have observed in the city of Philadelphia in a few blocks

on Chestnut street near the central part of the city.

In giving this brief description of some of the methods employed in this section of the city for this character of illumination, no attempt will be made to follow any particular route. On the contrary, I will first describe some systems whose merits lie mainly in the fact that they afford examples of how this character of lighting should not be obtained, and will then pass on to methods of intermediate efficiency, finally treating of some of those in which the results were more nearly equal to all that could be desired.

Having already referred to the bad effects produced by attempting to light a show window by a single open arc lamp placed in the middle of the window, it will be well to examine from actual observation the effects produced by two other methods of employing uncovered arc lights for show-window illumination.

In several instances the show windows consist of two windows that project beyond the store door, leaving a passageway between the windows so that each of them has two glass sides, i. e., one on the front and on one side, thus affording two points from which to observe the contents of each window. Several cases were noticed in the illumination of such windows where an arc lamp was hung in the space over the passageway. This method of illumination, while throwing a great volume of light on the goods in the windows, by no means resulted in satisfactory illumination:—

1. By reason of the excess of light.
2. From the shadows cast on the far side of opaque objects where the background was of such a nature as would not insure the illumination of the shadows by diffused light from the background, i. e., lighting by secondary radiation.
3. From the very serious objection that the glass of the window, acting as a mirror, tended to produce an image of the arc light in each of the windows at a distance back of the glass equal to the distance of the lamp in front of it. Where this image occupied the position of some of the articles in the window, it tended to produce marked indistinctness of vision.
4. Inefficient colour values due to the presence of too large a percentage of the violet or blue rays. With this exception, however, the colour values were good.

In other cases, arc lamps were placed over the pavement in front of windows at a distance of from 6 to 8 feet from the windows, thus subserving the double purpose of lighting the front of the store, the objects in the windows, and in many cases the objects in the store itself. This method is unsatisfactory owing to the reasons just mentioned. In some cases of this kind the image of the arc light obtained by reflection from the glass window was so marked that it was necessary to persuade one's self that there were not actually other arc lights in service in the store.

It scarcely need be mentioned that in either of these cases a great improvement would have been insured, at least as regards the serious objection of so much of the direct light entering the eye of the observer, by providing the globe surrounding the lamp with an opaque or at least a semi-transparent material that would cut off the light from the side of the observer, and radiate it on the opposite side into the store window. It is, of course, evident that where the open arc lamp is replaced by an enclosed arc lamp, which, except in very old installations, is now almost universally the case, that some of the objections to this method may be remedied, especially where such lamps are placed in the upper part of the show window, and are provided with a diffusion shade to throw the light downward, and are, moreover, protected by a curtain or a shade formed of any opaque or semi-opaque material placed near the top of the window to protect the eye of the observer.

A more serious objection, however, to the use of arc lights of any character for the illumination of show windows where the lamp is placed in the window itself, is to be found in the fact that it is necessary to recarbon these lamps at certain intervals, and in many cases the dressing of the store window is such that it is difficult to gain access to the lamp for recarboning without deranging the display of goods in the window.

Coming now to the use of incandescent lamps, the following example will serve as an instance of the excessive use and distribution of such lamps as would almost necessarily result in an unsatisfactory illumination. This is the case of a store containing two large show windows, the entrance to the store being some distance back of the street front, so that the windows can be observed from both the front and side. A vertical row of incandescent lamps is placed on the side of each window, and a horizontal row at the top of the window. There are twenty lamps at each front. The ceiling or top of the window space is occupied by forty-nine 8-candle-power incandescent lamps placed in seven rows of seven each. Each of these lamps is placed under a polygonal reflector, the sides of which are furnished with sheets of silvered mica or glass for the purpose of throwing the light downward. There are also rows of lamps placed on the sides of the window, the total number of lamps being 150. These lamps are bare or uncovered. The side of each window furthest from the entryway, as well as the back of the window, is provided with French plate glass mirrors, which, by successive reflection of light, give the well-known effect of multiplying the retinal images of the windows. It need hardly be added that such a method of illumination is eminently calculated to make the display of the incandescent lights the main feature of the show window. At the same time, if, by force of will, the eye of the observer is fixed on the goods themselves, a fair idea can be had of their general character and arrangement.

It is but fair in considering any method of lighting similar to that just given, to remember that after all, the exhibition of goods in a store window is for the purpose of attracting customers and at the same time fixing in their minds the fact that should they wish goods of such a description the stores in which they are sold are situated in certain parts of the city, so that a method of lighting which gives to certain stores such distinctive features as tend to fix their locations in the mind of the passerby may be productive of better results, so far as the sale of goods is concerned, than to present a quiet, unobtrusive, but thorough lighting of the goods exposed for sale.

Another example of the unsatisfactory effects produced by bare lights is found in the case of a show window, the lighting of which consists of a row of bare incandescent lamps placed near the floor of the window on the inside, and another row of bare lamps placed at the top of the window. No effort whatever was made in this case to obtain the ameliorating effects of diffused light. Neither the bare floor nor the walls of the window were made of material capable of diffusing the light. The objects exhibited were beautiful specimens of upright pianos, with highly polished cases. The effect of the illumination with no background was very unsatisfactory so far as the appearance of the goods was concerned. Moreover, the highly polished surfaces of the pianos, acting as mirrors, resulted in producing many images of the open lamps. By placing in such a window a suitable background

in the shape of a curtain formed of a material capable of diffusing the light and affording a contrast with the colour of the wood of the piano cases, placing similar material in the sides of the windows, and some neutral colour of carpeting on the floor, at the same time making the lamp globes of semi-translucent porcelain, and above all, so placing an opaque shade in front of the lights at the top and bottom of the window as to cut off the direct light from the observer's eye, satisfactory results would be obtained, although it is to be noted that the display of high polished goods of any character makes it difficult to obtain as satisfactory an illumination as with goods the surfaces of which possess marked diffusing power.

Coming now to some instances of satisfactory illumination, I will take the case of several windows of the same dimensions in which the illumination was obtained by twelve incandescent lamps placed in groups of two each, arranged, however, in the same straight line, and placed inside a rectangular cover or shade, the sides of which were covered with flutings of reflecting material. Practically the same number of lamps was used in each window, so that the total amount of light was the same in each. In some of these windows care had been taken to provide the proper background, both as regards its power of diffusing the light, its inability to regularly reflect the light, as well as its colour as regards the general colour of the articles exhibited. In all cases a curtain or a suitable shade was arranged so as to cut off all the direct light from the incandescent lamps from the eye of the observer. In this last respect, therefore, the distribution was similar in all the windows. The effects, however, were far from being equally satisfactory. In one window in which highly polished silverware was exhibited, as well as in a window in which jewelry was exhibited, good judgment had been exercised in the selection of a proper background, i. e., a dark-coloured velvet, which, by reason of the small quantity of light it threw off, afforded a sharp contrast both in the intensity of illumination and colour as compared with the illumination and colour of the articles displayed. Here an excellent general effect was insured, a good uniform illumination being obtained, and the eye of the observer being left in such a condition as permitted a minute examination of the high-grade articles under exhibition.

This illumination, however, was more satisfactory in the case of the jewelry than in the case of the silverware, for the simple reason that bare incandescent lights being employed in this installation, the illumination of many of the articles of silverware was greatly marred by the minute images of the bare incandescent lamps employed. This difficulty might have been, to a great extent, avoided by using frosted glass globes. The loss of light so entailed would have been more than made up by its improved distribution.

Another window was similarly lighted by protected incandescent lamps placed inside the rectangular reflecting box already referred to. Although the space to be illumined was the same, the windows all being of the same size and the number of lamps employed the same, yet, owing to the poor character of the background, in this case tongued and grooved highly polished quartered oak, an indistinctness in the general illumination resulted owing to the regularly reflected light from the oak boards, and their tendency to produce blurred images of the lights themselves.

In another window of the same dimensions as the preceding, and containing the same number of bare incandescent lamps similarly placed and protected by a common shade, an admirable example was afforded of an intelligently chosen background. The objects to be examined were handsomely bound books, with dark bindings, so that the proper illumination was difficult to obtain. Moreover, the highly polished covers would tend to produce images by reflection, though not to the same extent as with silverware. The formation of these images, however, was prevented by insuring a large quantity of diffused light from the sides of the window, which were draped with pure white muslin. The books, uniformly illumined, stood out in front of such a background with a peculiar and very agreeable sharpness.

In another store where a similar system of lighting was adopted, very beautiful effects were obtained as regards the illumination of jewelry. Unfortunately, however, in this store window a small plate-glass mirror placed in the middle of the window, marred the illumination by the images it formed of the bare lights.

Very excellent lighting effects were obtained from bare incandescent lamps placed inside of fluted-glass shades and located in the ceiling of a window. In this case twenty of such incandescent lamps were placed in two rows of ten each, the direct passage of the light to the eyes of the observer being prevented by the use of a partially transparent silk curtain. The illumination of the goods displayed in this window was of an exceptionally high grade.

Various types of shades or reflectors were employed in lamps placed both on the sides and in the top of the windows so as to shield the light from the eyes of those looking in from the street. It is to be noted here that in all these cases much more satisfactory effects would be obtained were the principle of reflection rejected, and the shades covered with some highly diffusing substance like aluminium paint.

Several instances were found where shaded incandescent Welsbach or other incandescent mantle lamps were employed as the illuminant. In such cases where these lamps were placed out of the line of direct vision, by the use of suitably placed opaque shades a very pleasing illumination was ensured, except, perhaps, in most cases as regards the absence of true daylight colour value.

In other instances, the use of the Hartel incandescent mantle lamp resulted in the production of much more pleasing daylight colour values. This lamp employs a current of heated air for the purpose of increasing the temperature of the glowing mantle. Here, therefore, is obtained a light whose colour values are much nearer the colour values of sunlight than are those of most incandescent mantle gas lamps.

German Petroleum Wells

According to a daily newspaper cable dispatch from Berlin, a new petroleum company, with a capital of $1,325,000, has been formed with the object of working 10,000 acres of oil lands in Hanover, and 6000 acres in Galicia. Among the shareholders are Count Ferdinand von Moltke, Admiral Thomsen and Privy Councillor Stemann, a publisher of Stuttgart.

Edmund Singer, a Hungarian expert, whose father discovered the Galician oil fields, is taking an active part in the organization of the company. The latter will refine in Germany. At first the new concern will supply fuel oil and later illuminating oil.

A telephone system controlled by the government is contemplated in Manitoba, Canada. The Premier of the province says that the prices of telephones should be made so low that labouring men and artisans can have the benefit, as well as merchants, professional men and others.

American Institute of Electrical Engineers

Abstracts of Papers on the National Bureau of Standards and on a Commercial Testing Laboratory

The National Bureau of Standards

By S. W. Stratton and E. B. Rosa

EARLY in the history of our government an office of weights and measures was established in connection with the Coast and Geodetic Survey, for the purpose of providing suitable standards of length in connection with its work. At about the same time it became necessary for the Secretary of the Treasury to adopt standards of mass and capacity, and to provide copies of the same for use at the various custom houses, thus increasing its functions to include mass and capacity. Later he was directed by the Congress to provide copies of these standards of length, mass, and capacity to the various States. This work was necessarily delegated to the office of weights and measures.

Precision measurements of length necessitated the adoption and comparison of thermometric standards through the ordinary range of temperature. During the last years of the office of weights and measures it had begun in a very small way the testing of standards of electrical resistance and electromotive force, but owing to the limited facilities of the office its work was practically confined to the bare necessities arising in connection with the work of the Treasury Department.

In urgent and important cases comparisons were made for other departments of the government and for the public, although no provision was made directly for that purpose. In the meantime the scientific, manufacturing, and commercial interests of the country had assumed gigantic proportions. Accurate measurements were employed where before guess work and rules of thumb were considered quite sufficient. Scientific work, and the introduction of scientific methods of manufacturing necessitated accurate methods of measurement. The dissemination of scientific knowledge and the adoption of the interchangeable method in manufacturing made the use of uniform working standards imperative, a result to be obtained only through primary standards of the highest type, and a central institution provided with the facilities for their comparison with secondary or working standards.

It was not until 1901 that our government provided suitable standardizing facilities, although the necessity for such work had been recognized for many years previously. In fact, the demand for it had become so great that for some time previous to the establishment of the National Bureau of Standards, we were compelled to avail ourselves of the facilities of foreign governments, principally those of the Physikalisch-Technische Reichsanstalt, of Germany, an institution to which too much credit cannot be given for having demonstrated the value of such institutions founded on broad scientific principles, and independent of commercial considerations.

The work of that institution is too well known for further comment, but it may be safely stated that were it not for its magnificent example, the Bureau of Standards would probably not be in existence to-day. At that time the United States held a creditable position in physical science and had some of the best laboratories in the world; it was leading in the manufacture of electrical and other machinery, and in some kinds of scientific instruments. To be compelled to ask foreign laboratories for standards and standardizing facilities was clearly a situation that ought to be corrected. The Congress acted promptly when the matter was brought to its attention.

Funds were appropriated for the construction and equipment of laboratories and for a small scientific force, with a view to increasing the latter as soon as the laboratories were completed. Since it would require at least two to three years for the planning and building of the laboratories, temporary quarters were at once secured in connection with the quarters formerly occupied by the office of weights and measures.

Immediately after the passage of the act establishing the Bureau of Standards, March 3, 1901, the planning of the laboratories was begun, as well as the selection of the scientific staff, and the development of some of the more important methods of testing was actively taken in hand.

It was decided to erect two buildings at Washington, one of which should contain the mechanical plant, instrument shop, and other departments requiring heavy apparatus; the other, a physical laboratory, situated at some distance from the first, and as far as possible free from machinery or mechanical disturbances. The amount appropriated for the buildings, exclusive of the equipment, $325,000, would not permit of ornamental or expensive construction; nevertheless, it was sufficient to erect two strong, substantial, fireproof buildings, well suited for laboratories. A third building to accommodate machinery for the liquefaction of gases is nearly completed; it is practically an extension of the mechanical laboratory to the west.

It is proposed to erect a similar but larger building at the east of the mechanical laboratory for the testing of engineering instruments, the strength, and other properties of materials. At the east and west ends of the physical laboratory it is proposed to erect in the future two buildings, each about the size of the present physical laboratory, one to be devoted to electrical work, the other as a chemical and metallurgical laboratory. The entire group of buildings will be connected by tunnels through which heat, power, light, and other facilities will be distributed from the mechanical laboratory. In designing the buildings and their equipment, special attention has been paid to the production and distribution of general laboratory facilities, the details of which were described in the paper. The physical building has now been occupied for about a year and has been found to be exceedingly well adapted to the purpose for which it was designed.

A Testing Laboratory in Practical Operation

By Clayton H. Sharp

THE laboratories with which the electrical engineer concerns himself can be divided into three classes:—first, those having to do with the conservation of units

and primary standards, and with the certification to the accuracy of secondary standards which are to be used in general practice; second, those engaged in making experiments, researches, and tests having an immediate commercial end in view; third, those used primarily for purposes of instruction.

Under the first class come the great national laboratories. One of the best of this class we are now so fortunate as to have in our own country, in the laboratory of the National Bureau of Standards.

Of laboratories of the second class many are in existence. The large and progressive manufacturing and operating companies maintain well-equipped laboratories for the research and testing work, so vital to them.

But in spite of the existence of these laboratories, many electrical workers are practically without laboratory resources. The cost of proper laboratory equipment is by no means small, and the salaries of laboratory experts is of considerable moment if the product submitted to test is of only moderate value. Consequently, manufacturers of smaller output, purchasers of electrical supplies in moderate quantities, inventors, users of electrical instruments, and many consulting engineers have found it impracticable to provide themselves with laboratory facilities. To such parties a desideratum would be the establishment of a completely equipped electrical laboratory, as a quasi-public institution, where all desired tests and experiments would be made at a reasonable expense, and exactly as they would be made in a private laboratory, and if desired under conditions insuring privacy.

Recognizing this fact, the Electrical Testing Laboratories have been formed in the city of New York as a business enterprise. This organization has equipped and put into operation an extensive plant for testing purposes.

The Electrical Testing Laboratories have now been permanently established and in practical operation for nearly two years in a large and substantial building of adequate size, unusually substantial, and well adapted to laboratory purposes, while the equipment of apparatus is most generous as to quantity, quality, and range. The arrangements for obtaining large quantities of electrical power are also excellent. In other words, an earnest effort has been made to obtain as perfect an electrical laboratory equipment as is practicable.

As has been indicated in the foregoing, the purpose of these laboratories is to fill a hitherto existing lack in the electrical field. The Electrical Testing Laboratories are not engaged in producing any manufactured product. They do not attempt or expect to supplant the testing laboratories organized by operating and manufacturing companies, but rather to supplement them. By abstaining from giving advice or rendering opinions they do not encroach upon the particular province of the consulting engineer, while they place at his disposal facilities for obtaining such experimental data as he may need in his practice. It will thus be seen that the purposes of this enterprise are not in the least antagonistic to any other industry or established interests, but the establishment is in a position to be of impartial service to all. The National Bureau of Standards maintains the primary standards; the Electrical Testing Laboratories devote themselves to commercial electrical measurements for the promotion of electrical industries; thus these two laboratories are mutually supplementary, the one undertaking a work which is essentially a function of government, and the other applying the results of such work to productive industries.

DISCUSSION

At the conclusion of Dr. Sharp's paper, President Wheeler said that the subject of standards is one in which the Institute has always taken a great interest, and some of its prominent members have been largely instrumental in obtaining the adoption of certain standards. The Institute recently appointed a Committee on Standards, and he called upon Professor Crocker, the chairman of that committee, to open the discussion on the interesting papers which had just been read.

Professor Crocker heartily agreed with the closing paragraph of Dr. Sharp's paper congratulating the electrical industry upon the work of the National Bureau of Standards. The Institute has done a great deal of work in encouraging standardization, but it remained for the government to do something that was really permanent, and to give to the public, in contradistinction to the electrical profession, the standards and standardization that are needed in business, and there is reason for congratulation that this work is in such excellent hands.

The matter of international standardization is also important, and the electrical profession throughout the world is to be congratulated on the fact that the international character of standardization is much more advanced in the electrical industry than in any other engineering profession, or perhaps any other branch of human interest, inasmuch as the electrical units are international, and in fact have been since the Chicago Congress of 1893. The matter of international standardization of electrical and other units is already well established and is in good hands, an international organization having been effected.

The standardization of engineering practice,—that is, the standardization of electrical machinery,—is a different matter. There are many phases of standardization, and those fundamental standardizations to which the first and, more or less, the second paper referred, are taking care of themselves; but the matter of standardization of machinery, while pretty fairly well established and recognized and carried out in this country, is quite unsettled in some respects, even in this country, and there is very little international standardization in electrical machinery. But the time will probably come when even that will be attempted.

The president had suggested a term which the speaker thought applicable to this whole question, namely, "uniform practice." That is an excellent term to designate all the efforts that are being made to bring about uniformity in each and every branch of science and applied science. For example, the mechanical engineers are responsible for steam engine practice, and electrical engineers are responsible for electrical generator practice, but both must get together in direct-connected units. Professor Crocker thought the time would come when standardization would extend to screw threads, hose couplings, and dynamo diameters and speeds.

Prof. George F. Sever spoke in complimentary terms of the work of the Electrical Testing Laboratories in New York. Their existence is very beneficial to the electrical testing laboratories of the universities. They relieve the staff at the universities of a lot of commercial work that completely disorganized and impaired the proper work of the university by taking up the time of the professors and utilizing the laboratory equipment. Further, the students were not so well trained as they can be under a purely academic standard.

Prof. C. A. Doremus spoke on the subject from the standpoint of the chemist and electrochemist. To the chemist the knowledge that his volumetric apparatus is of standard type is of greatest importance. Not only

are accurate weights needed, but also accurate measures. He understood the standard U. S. gallon was standard at no particular temperature mentioned in the act which made it standard; hence, it has been guesswork on the part of the officials ever since it was made a standard as to what temperature should be employed in the use of that standard gallon.

When it comes to testing materials, such as steel and other things, pure chemicals are needed, and the chemical manufacturer is beginning to recognize that it is worth his while to be able to put into the hands of those who need them, chemicals of standard quality. They may not be absolutely pure; in some cases that is considered to be commercially impossible, for a chemically pure material that is preserved in bottles acquires from the container sufficient impurity to reduce it to a lower standard; but it is of the highest importance for the chemist to know, when he is using a particular acid or particular salt, that it is not contaminated with other things, or if so, how great the contamination is, and that is the feature which has been attempted to be realized by the chemical manufacturers.

William McLellan, of Newcastle-on-Tyne, England, thought it worth while to emphasize the value of the National Bureau of Standards to the universities and to scientific men generally. If one considers the evolution and perfection of many of the great instruments of the world, as, for instance, Professor Rowland's apparatus for determining the mechanical equivalent, and notes the opportunities for errors, the difficulties of the situation will be appreciated. Tremendous care had to be taken, and after the results were calculated, they had to be recalculated many times and worked over, simply on account of certain calibrations and calculations which to-day would, he thought, not enter into such a measurement, for such a bureau as the National Bureau of Standards would take care of all that.

The speaker thought that standardization of material, as has been suggested, would stifle all proper experiment and improvement.

Dr. S. W. Stratton, answering a question relative to the extent to which the National Bureau of Standards is making commercial photometric tests, said that this question arises in connection with nearly every phase of work done by government bureaus. For example, in the case of weights and measures, the line drawn between fundamental standards and local standards is sharp, and yet the bureau is bringing about relations between the State and city sealers of weights and measures which will give the Bureau the control of the fundamental standards, and by associating the Bureau with them, they will be instructed in the various methods, and yet will be doing all the routine testing,—the testing of commercial weights and measures. There is hardly a section of the Bureau's work which can be divorced from that kind of work.

The policy has been to take up pretty thoroughly the commercial testing of photometric standards as far as it relates to government work. That keeps the staff in touch with practical methods and things of practical value. There is much of that testing to be done with the government. The Bureau has not gone outside of that, except in cases where it has not been convenient for the public to get at the standards of the Bureau. That question will arise in connection with the clinical thermometers, and Dr. Stratton thought that the relation between the two, while it may not be very important, will be sharply marked, but the relation will be pleasant.

John W. Lieb, Jr., said it had been his privilege to be present and to take part in some of the meetings of the committee of Congress that had before it the consideration of the question of the establishment of the National Bureau of Standards, and some of the members of that committee had doubts as to the needs of such an institution, and as to the possibilities of either its misdirection, or of its going out into fields of work which led no one knew where. It is a high compliment to Dr. Stratton's energy and ability that the work of the Bureau has been carried out with such great success.

Americans are apt to be taken to task for their utilitarian spirit, but in this institution there is good evidence that the nation at large appreciates the importance of high standards, of careful scientific investigation, and of experimental research. He thought that the National Bureau of Standards at Washington would also play a very important part in enlisting the sympathy and co-operation of the mechanical industries in this country toward the adoption of the metric system.

Messrs. Mailloux and Goldsborough also participated in the discussion, which was closed by E. B. Rosa, who stated that the total cost of the equipment of the National Bureau of Standards to date is not more than $600,000.

Steam Turbines as Reserve Power in Water-Power Transmission System

THE Missouri River Power Company, operating in the vicinity of Helena, Mont., and notable as having one of the highest voltage transmissions in the world, has begun the erection of a steam turbine power plant to operate as a reserve to their present water-power plant. A large part of the output of the Missouri River system is transmitted to the city of Butte and the Anaconda district mining properties, and the service has grown to such an extent as to warrant the erection of a reserve plant as a protection against serious fluctuations in the available water-power.

Turbines of the Westinghouse-Parsons type will be installed, the initial equipment consisting of two units of 2000-KW. capacity each, operating at 1200 revolutions per minute, with 150 pounds steam pressure, 28-inch vacuum, 100 degrees superheat. They will be capable of delivering continuous overload of at least 50 per cent. condensing, or full load without the assistance of a condenser. The generators will be of the revolving field type, and completely enclosed, with forced ventilation. This feature will entirely eliminate the peculiar hum of the high-speed turbine generator of the open type. The generators will operate at 1200 revolutions per minute and deliver 60-cycle, three-phase current at 2400 volts. The motor-generator exciting and complete switchboard equipment accompanies the turbine plant.

The Westinghouse Machine Company, builders of the turbines, will also equip the boiler plant with their mechanical stokers.

According to Chas. H. Parker, of the Boston Edison Electric Illuminating Company, the cost of coal handling at the company's plant averages 15.35 cents per ton from boats to bunkers, including repairs to machinery. The equipment consists of a tidewater pier with two unloading towers, an open storage yard, bunkers in the station, and conveyors driven electrically. The cost of handling the coal from lighters is 5.27 cents a ton, from barges 8.05 cents, from steamers 9.36 cents, and from schooners 15.04 cents. About one-half of 1 per cent. of the current output of the station is now used for running the coal-handling plant, but it is expected that this will be reduced by improvements now being made.

THE ELECTRICAL AGE

Volume XXXV Number 6
2.50 a year ; 25 cents a copy

New York, December, 1905

The Electrical Age Co.
New York and London

ESTABLISHED 1883

Published monthly at 3, 5 and 7 W. 29th Street, New York City.
Telephone No. 1617 and 1618 Madison Square. Private branch exchange connecting all departments. Cable Address—Revolvable, New York.

SUBSCRIPTION RATES

The Electrical Age will be sent post free anywhere in the United States and its possessions, Canada and Mexico for $2.50 per year, single copies 25 cents. To Great Britain and all countries embraced in the postal union, $5.00, 20 shillings, 25 francs, 20 marks, or 15 rupees. Send subscriptions to our nearest branch office or agency.

NOTICE TO ADVERTISERS

Insertion of new advertisements or changes of copy cannot be guaranteed for the following issue if received later than the 15th of each month.

LONDON OFFICES

Business Department, 33, Bedford Street. Editorial Department, 22, Henrietta Street. Covent Garden, Strand, W. C.

London Telephone, Post Office, 3807 Central. Private branch exchange. London Cable Address—Revolvable, London.
All remittances to London Office should be crossed London and County Banking Company.

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Leading Articles

Index to Volume XXXV

The Index to Volume XXXV of THE ELECTRICAL AGE,—July to December, 1905,—will be ready on January 1, 1906, and will be mailed free on application.

Testimony by Phonograph

THE use of a phonograph in a court trial to demonstrate sounds and noises was recently permitted for the first time in the United States by Judge Wait, in the Superior Court at Boston. The instrument was employed in a suit against the Boston Elevated Railway Company by the trustees of the Albany Building, on Beach street, Boston, to recover damages alleged to have resulted from the location, construction, and operation of the company's elevated lines.

Records were submitted to the jury for the purpose of demonstrating the relative noise of the elevated trains and other sounds in the vicinity of the building. Counsel for the road objected to the use of the phonograph on the ground that the development of the instrument and the art of managing it were not sufficiently advanced or of sufficient exactness to warrant its admission as evidence in a court of law, while the plaintiffs contended that the phonograph is one of the most accurate and scientific of recording instruments, offering it upon the same ground upon which photographs are put in evidence, and claiming that originally the photograph was forced to overcome the same objections now raised against the use of the phonograph. The latter has been put in evidence at least once in the English courts, and Judge Wait allowed its use in his discretion in the case at hand.

The Ultimate Size of Electric Power Stations

IT is safe to assume that the most economical system of electric current supply for some years to come will consist of the present multiphase generating station, connected to sub-stations in which will be located the transforming apparatus as the connecting links to the distributing systems already in use.

In reviewing the progress of the past few years, however, one cannot help but wonder whether a limit has been reached in the ultimate size of this generating plant. As it is already practical to consolidate various systems, and supply them from one generating station, would it not also be possible to combine, in turn, these large generating plants when they are located in the same territory, so that all energy can be distributed from one central point? It seems almost improbable that this development should ever occur, when we consider the size of the plants now being erected in London, New York, or Chicago, and yet the carrying out of such a proposition is by no means an impossibility or even an improbability.

The question as to the ultimate size of the main generating station, and the number of sub-stations that can be operated from it, as pointed out by Wm. S. Barstow not long ago in a discussion of the subject, is limited only by the development of details in the design and operation of generating machinery. It is true, the efficiency of electrical equipments of the present day has reached a very high figure; but the fact that the steam plant rarely exceeds a heat efficiency of 10 per cent. points out some of the possibilities of the future. There was a time in the history of generating stations when labour was an all-important item, and when fuel amounted to rarely more than 15 per cent. of the total operating expenses. As the size of the generating units has increased and the station machinery has become simplified, the percentage of labour in operation has been reduced to a very large extent; in fact, almost to the limit of reliability of service.

Fuel, on the other hand, has formed, and will continue to form, an ever-increasing percentage of the total station expenses, and the problem will, sooner or later, resolve itself into that of transmission of energy by electrical conductors vs. railway. This may mean another change in the location of the main generating plant, and the present large station may itself, in turn, become a sub-station, or be abandoned

altogether. When several of the present stations which supply sub-stations shall give way to one large generating plant of many hundred thousand horse-power capacity, located in close proximity to the coal fields, then, and not till then, may we even look for a cessation in present multiphase progress. The importance of the coal industry in connection with the development of electrical problems is becoming more important, and any radical movement, such as this, might bring about further combinations with properties at present transporting the fuel, and which by that time may themselves be electrically operated.

The question of operating such combined enterprises by electrical energy generated by water power is not to be considered in such a colossal undertaking, since the average water power of to-day, more or less limited in ultimate capacity, would form but one small unit in the general plan. Such enormous development as the combining of present already large properties may be thought more or less visionary, due to the apparent difficulty at the present day of suiting the size of the generating unit to new economical conditions; but the fact is always evident that when the proper conditions arrive there will be no lack of engineering ability to successfully overcome obstacles which at this time may seem to be insurmountable.

Submarine vs. Underground Electric Cables

THE recently reported serious consideration of the project of putting cross-country telephone wires under ground, at least on one heavy-traffic division of the Bell system, so as to avoid the perennially recurring costly interruptions of the service by severe storms, makes it worth while to recall here what may be called the submarine plan held under advisement in Great Britain several years ago, of insuring reliable telegraphic communication regardless of weather conditions.

It has been noticed that at no time since the successful laying of the Atlantic cables has telegraphic communication between Europe and America been interrupted, and, in fact, that at the time of the great American blizzard of 1888, which extended over a large portion of New York and New England, the only telegraphic communication possible for many hours between New York and Boston was carried on by way of the Atlantic cables. The suggestion, therefore, was made to connect the important sea-coast cities of Great Britain by submarine cables, which could be laid more rapidly, and, if anything, more economically, than underground cables, of which latter, it may be noted, more than one have been laid,—a 76-conductor cable, for example, which has been in operation for several years between Birmingham and Liverpool.

This plan of connecting the seaports of Great Britain by submarine cables, however, was not altogether original, inasmuch as this method of connecting a number of the chief ports of the islands of the Philippines was put into practical operation several years ago by the United States Government, not, however, so much to secure immunity from interruptions of service due to storms, as because of the nature of a great portion of the country which made the construction and maintenance of pole lines a matter of almost insurmountable difficulty.

Electric Locomotives for Mine Haulage

THE electric locomotive, considered as a machine, has many points in its favour for mine use. For a given hauling capacity it is by far the most compact of all forms of motive power; it is simple in construction and convenient in operation. Externally, it consists of a massive cast-iron box without visible mechanism,—a construction excellently adapted to the required work, as the frame serves to give the machine the necessary weight and protects the mechanism against injury in case of derailment or otherwise in rough mine service.

A determination of the proper locomotive equipment for a given mine is dependent upon a variety of factors. These have been outlined by George Gibbs, the present chief engineer of electric traction for the New York City terminal of the Pennsylvania Railroad, as comprising the maximum grade over which it is desired to operate, the condition of the track, character and condition of the wagons, and a general knowledge of the haulage scheme, such as length of haul and output desired per locomotive.

The importance of all these considerations will be apparent when it is observed that mining conditions necessitate extremes for grades and curvature, and that the wagon resistance is far greater than that found on surface railways. Thus mine grades are frequently as much as 4 to 6 per cent., and curves as short as 15 feet radius; wagon resistance varies generally between 30 and 60 pounds per ton weight, never falling below 20 pounds, and frequently exceeding 60 with badly worn, loose rails. The rails are generally light and in poor condition, so that the adhesion is seldom better than one-sixth of the weight on drivers for tractive effort. When the above conditions have been ascertained, the size and number of locomotives required to handle the mine output can be determined.

The saving to be effected by the introduction of electric haulage in a mine using mules should rightly include an estimate of the value of increased output and economies following upon decreased cost of cutting entries and the possibility of operating upon heavier grades, as well as the usual items directly chargeable to haulage. These indirect economies vary between wide limits, being greater as the length of haul increases and as the head-room becomes more limited; but they cannot be expressed in general figures. The direct comparison of operating and maintenance costs, however, shows that under the most favourable conditions mule haulage costs at least three times as much per ton of product as electric haulage; and in mines with heavy grades against the loads, mule haulage is often more than five times as expensive. Expressed in figures, the average saving to be expected by the adoption of electric instead of mule haulage is from 4 to 5 cents per ton of output, and in large mines with heavy grades the saving is frequently as great as 8 cents per ton.

The American Society of Mechanical Engineers

ANNUAL MEETING, DECEMBER 5-8

THE annual meeting of the American Society of Mechanical Engineers, which was held at New York City from December 5 to December 8, was in every sense a record-breaker. Over 1300 members and guests were registered at headquarters, and attended the various business and social sessions.

With wise forethought, based upon the experience of last year, the management had decided in advance of the meeting to secure more commodious quarters for the meeting instead of having the sessions at the house of the society as in previous years, and the two large meeting rooms of the New York Edison Company, at its uptown station in West

Twenty-seventh street, were happily secured for the purpose, so that, despite the very large numbers to be accommodated, there was comfort for all.

In the way of entertainment and instruction combined, no doubt the two most interesting new features of the meeting were the business session on board the large new Hamburg-American Line steamship "Amerika," and the excursion to the new establishment of the Henry R. Worthington Hydraulic Works at Harrison, N. J. On board the "Amerika," the members and guests were received by the company's representatives, E. L. Boas and Julius P. Meyer, by whom every possible courtesy was extended. The ship was inspected from stem to stern, and the Hamburg-American Line's hospitality was freely tested, the company having most liberally provided for refreshment on board.

In connection with the visit to the Worthington Works, a special train had been kindly supplied through the courtesy of the Lackawanna Railroad, and after luncheon at the works, the members and guests were conducted through the various departments.

The reception at Sherry's was one of the social features of the meeting as usual, and as in former years, proved an unqualified success. One other feature of the meeting deserving special mention was a lecture by Prof. R. W. Wood, of Johns-Hopkins University, dealing with "The Photography of Invisible Phenomena." Following this lecture, as well as on the opening night of the meeting on Tuesday, December 5, on which President John R. Freeman had delivered the annual presidential address, dealing with "Fire Protection," there were informal social reunions of the members and their friends.

The papers read at the meeting combined the following:—

"The Use of Natural Gas Under Boilers." By Jay M. Whitman.

"Reinforced Concrete Applied to Modern Shop Construction." By E. N. Hunting.

"Measurement of Air Flowing Through Circular Orifices in Thin Plates." By R. J. Durley.

"Results of Preliminary Producer Gas Tests. United States Geological Survey Testing Plant. St. Louis." By R. H. Fernald.

"Pressure Drop Through Poppet Valves." By Charles E. Lucke.

"Test of Elevator Plant. Trinity Building, New York City." By A. J. Herschmann.

"The Realization of Ideals in Industrial Engineering." By H. F. J. Porter.

In addition to these there was a lengthy discussion of the subject of "Bearings" in the shape of a number of short papers,—all of great practical interest.

The newly-elected officers of the society, as already forecast in these pages last month, are:—

President, Fred W. Taylor; vice-presidents, Walter M. McFarland, Edward N. Trump, and Robert C. McKinney; treasurer, Wm. H. Wiley; and managers, Walter Laidlaw, Frank G. Tallman, and Frederick M. Prescott.

Chattanooga, Tenn., has been fixed as the place for the spring meeting of 1906.

Regarding the recent single-phase railway installations in the United States, "The Electrician," of London, says:—

"Altogether the information given is encouraging, and it makes us desire more. It makes us desire, also, that there were greater facilities in our own country for these 12-inch-to-a-foot scale experiments. Where is the British manufacturer, and where the British railway board that will venture so much in trying a new device? It is some consolation that our friends in the States publish their results so freely, and in this also they show their wisdom; for it is fairly certain that whenever a demand arises for single-phase equipments, the first lots will come from Schenectady or Pittsburg, where they are already "standardized," listed, priced, and the characteristic curves plotted, traced and blue-printed."

Under the auspices of the Hudson River Electric Power Company, of Albany, N. Y., there was recently an important gathering at the office of Dr. D. L. Kathan at Schenectady, N. Y. Those present included the heads of departments of the company and its allied and auxiliary companies at Mechanicville, Spier Falls, Utica, Schoharie, Watervliet, and was arranged by Brice E. Morrow, who is manager of the Electric Power Company. Dr. Kathan delivered an exceedingly interesting discourse on the best and most modern methods of resuscitating a person who has received an electric shock, and also the treatment of persons who have received electrical burns. The lecture was illustrated with a living subject. It is proposed to have similar lectures in the future, and every precaution is to be taken to insure the safety of those employed by the several companies.

Standard Electrical Rules

THE national conference on standard electrical rules, held under the auspices of the National Electric Light Association, met in the auditorium of the Edison Building, at New York, on Monday, December 4, 1905. The meeting lasted over four hours, and was attended by twenty-two members,—representatives of the various national associations and of the manufacturing and electrical operating companies.

According to custom, this meeting was held two days before that of the Board of Fire Underwriters, which took place on December 6. The object of the meeting was to elect officers, adopt amendments to the constitution, and make whatever suggestions were deemed necessary to the fire underwriters for their adoption. W. H. Blood was elected president, and C. J. H. Woodbury, secretary. Considerable discussion arose on the subject of electrical fire risks, several members claiming that the Board of Fire Underwriters gave greater prominence in their reports to fires caused by electricity than to those due to other illuminants. A resolution was finally adopted requesting the underwriters to modify their statements in this respect.

Mr. Goddard, representing the Board of Fire Underwriters, gave some interesting testimony regarding electrical fires. He said statistics proved that electric light, when properly installed, was the safest form of artificial illuminant, but when improperly installed, was the most dangerous. In comparison with gas, he said, the fact that the electric current could be led so easily over wires that were merely twisted together, made an electrical installation more dangerous than gas piping, for the reason that such defective wiring could not be easily detected, whereas an imperfect joint in gas piping would at once be noticeable from the odour of the escaping gas; also, that when a gas or a kerosene light is turned out, the fire risk is over, whereas in the case of an electric light the voltage is still on the conductors, and, if the wiring is not first class, is liable to cause sparks and possibly fire after a lamp is switched out of circuit. He claimed, however, that electrical fire losses were not increasing in proportion to the increased use of electricity, and this proved that the underwriters were grasping the situation better than ever before. Mr. Goddard also spoke well for the higher standard of electrical inspections.

From the World's Technical Press

Electric Cars in Collision

ALTHOUGH the development of electric traction in America has only fairly begun, the number of accidents reported appears to be larger in proportion to the passenger miles than for the steam roads. One of the most frequent causes of accidents, says "The Railway Age," is the collision of heavy cars having weak body and end construction, which results in fatalties even more numerous than those on steam lines where the substantial platforms and vestibules are used.

The design of large and heavy electric cars for elevated and interurban service in this country appears to have little relation to the danger of their destruction in collision, and their end construction, in particular, is weak, especially at the drawbar and buffer. The greatest safeguard is efficient brakes, and while the weight of some interurban electric cars is now greater than that of many coaches on steam lines, little attention has been given to brake efficiency for such equipment, excepting on the large metropolitan lines, and it is safe to say that the brake capacity of most of the interurban electric cars is not nearly equal to that of cars of the same weight on steam roads.

The front end of the motor car is mechanically equivalent to the locomotive, but the latter is a strong protection to the cars back of it by reason of its weight and strength, while the former is often the weakest part of the train. This is a condition which is not recognized in electric car construction generally, and the safety of passengers in such trains should be more strongly guarded. In order to accomplish this, the most convenient door arrangements for handling passengers and baggage may have to be abandoned. Vestibule buffers, or an equivalent which would prevent the overriding of car bodies in ordinary collisions, should be used, and the car end generally should be built with special reference to its resistance in collision, instead of being simply a light affair for a convenient lookout. Electric traction is growing rapidly, and the weight and speed of electric trains are becoming equal to those of the steam roads, but equivalent safeguards for passengers are not always provided. In the consideration of these, the control of electric trains by efficient brakes, extra strong end construction and buffers for the motor cars. should not be neglected.

Electrolyzed Salt Water for Disinfecting Purposes

W. F. ALEXANDER, the medical officer of health for the metropolitan borough of Poplar, England, has presented a report to his committee upon the manufacture of electrolyzed salt water for disinfecting purposes. He shows in his report that this disinfectant can be economically obtained, and that it would be quite as effective as the disinfectants now in use by his departments.

The following extracts from his report will revive interest in a process which, according to "The Electrical Engineer," of London, was introduced in England some ten or twelve years ago for the treatment of sewage by means of electrolyzed salt water. This was the Hermite process, the use of which has not been extended beyond the few places where it was first tried. It is quite likely, however, that as a disinfectant for private use or for flushing drains that the electrolyzed salt water may be more economical than the disinfectants now used. The production of the same would provide a steady and valuable load for the local electric supply station, as the process could be carried out in such a way as not to clash with the lighting peak. This would enable a very cheap supply of electricity to be given.

The Alexander process consists, briefly, in passing electricity through salt water, thereby converting the magnesium and sodium chlorides into hypochlorites.

Mr. Alexander in his report states:—"I have been in communication with a firm of electrical and mechanical engineers, Messrs. Geipel & Lange, of Vulcan Works, 72a St. Thomas street, S.E., the successors to Messrs. Paterson & Cooper, the firm which installed the plant (Hermite system) at Ipswich, Lytham, and the Victoria Hospital, Netley. These engineers, at my request, have been in communication with friends in Paris, and finally write me as follows: 'This is as small an apparatus as we could make, and is capable of producing 250 litres of disinfectant solution per hour, having a strength of 1 grm. of chlorine per litre. Such a solution is strong enough for deodorizing sewage and other like purposes, but we are of opinion that for ordinary cases of domestic sanitation a solution of half this strength would be sufficient, so that it would be possible by watering down to obtain from this apparatus 500 litres of solution having a strength of ½ grm. of chlorine per litre. We believe that with this apparatus and with solution of this strength you could have excellent results. This electrolyzer would require 30 amperes continuous current at a pressure of 110 volts, but, if more suitable to you, 20 amperes would be sufficient for longer periods, or, if necessary, 40 amperes could be put into the apparatus. It would be necessary to have a rheostat in the circuit to regulate the current; the only other apparatus would be a tank or reservoir placed at a higher level to the electrolyzer containing the solution to be electrolyzed, which reservoir should be connected to the electrolyzer by a rubber pipe. Our price for this electrolyzer complete,

but without the tank just referred to, would be £95, carriage from Paris extra. The solution to be employed with this apparatus should be composed of water, 1000 litres; ordinary salt, 40 kilos; chloride of magnesium, 10 kilos.' "

Mr. Alexander states that in his opinion the health of the district must be materially enhanced by the use of electrolyzed salt water as a disinfectant, and a great saving of money will be assured to the ratepayers. It is understood that if the proposal is adopted, the strength of the solution actually delivered to the public would be one containing 4 grm. of chlorine per litre. It is to be hoped that the proposed system will be given a good trial in Poplar. Success there would lead to its adoption elsewhere.

Boiler Corrosion

BOILER corrosion, says "The Iron Age," is due to other causes than mere hardness of the water. The present methods of water purification usually leave a residue of sulphate of soda in the water, which becomes more and more concentrated as time goes on and is found to attack the boiler to a considerable extent. Nitrates and chlorides, which are also found in the water, are even more corrosive than the sulphates, and worst of all is chloride of magnesia.

It is therefore necessary to keep the concentration down below the point where these salts will attack iron or steel. As the water in the boiler will not be uniformly mixed, the concentration is apt to be a maximum where the evaporation is greatest or at a point of greatest heat in the boiler, and these points are likely to be the first attacked. It has been recommended that a boiler be emptied once a week and thoroughly washed every two months in order to avoid the accumulation of these soluble salts.

Static Electricity in Ore Separation

FOR nearly five years, according to W. G. Swart in the "Engineering and Mining Journal," electrostatic ore separators have been in successful use. This is true, at least, of the Blake-Morscher machine, of which more than forty are in operation. When this machine was first introduced commercially, its use was largely confined to those ores whose constituent particles differed widely from each other in conductivity.

Another process developed by this company, and one not widely known, is that which depends for its operation on the specific inductivity of various materials. In its simplest form, shown in the annexed illustration, the apparatus now in use consists of a hopper and feeding device A, charged poles B and B_1, and receptacles C, C_1, C_2 and C_3.

The poles B and B_1 are usually highly charged with electricity of opposite sign, but not necessarily of the same potential. When a stream of ore particles is dropped through the field between the two poles, the particles are urged out of their original path and into different directions, with varying degrees of force, depending on differences in their specific inductivity; the several minerals fall, each into its own receptacle at the bottom. Nothing could be much simpler, yet the thing is

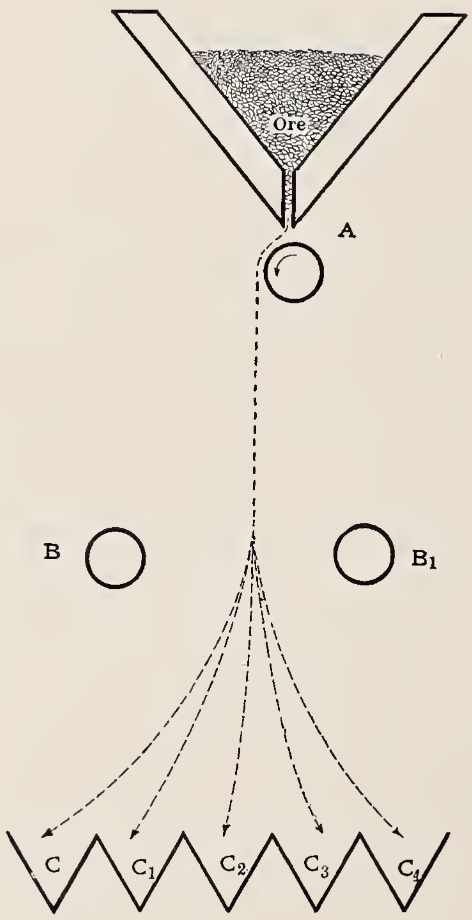


DIAGRAM OF APPARATUS FOR THE SEPARATION OF ORES

positive, and the results are remarkable.

With such an apparatus it is possible to separate substances independently of their conductivity. As an example of materials of approximately equal conductivity, fluorite may be separated from quartz or barite, barite from blende, and feldspar from corundum.

It must be evident that this enormously widens the field of the electrostatic process; and, when used in connection with conductivity separations (where the conductivity is either natural or produced artificially), it gives a range covering almost all known minerals.

The electrostatic generator has also been made closely to approximate the dynamo in reliability. The machine of the laboratory or of the physician, running uncertainly a few moments at a time, has given place to mechanically strong and powerful mica-plate generators, running continuously night and day, in damp and dusty mills, with ordinary help.

As now used by the Blake Company, all brushes and other moving contacts are abandoned; the field-plates are in static shunt with the generating rotors, so that the machines are self-exciting. The ozone and nitrogen compounds which are continuously formed are removed as fast as generated, by a forced draft of hot, dry air, which also prevents all moisture deposits, so that the machines are now independent of atmosphere or altitude.

The Spacing of the Wires on High-Pressure Power Lines

MR. W. B. ESSON in an article in "The Electrical Review," of London, on the spacing of wires on high-pressure power lines says that the side of the equilateral triangle formed by the three wires of a power line should be as short as possible, provided it is sufficient to prevent the separate wires from swaying together in the wind, to ensure that short-circuits are unlikely to occur through other causes, and to render impossible an arc being sustained across the wires should one be accidentally started.

The Niagara-Buffalo line when it was first put up had two three-phase circuits—six conductors in all—supported on a single cross-arm with 18 inches between the wires. To create firework displays, pieces of wire, barrel hoops, and other bits of metal used to be thrown over the wires, starting 11,000-volt arcs between them, which arcs would hold and would be blown by the wind to a considerable distance along the lines, to the great delight of the unauthorized experimenters. The conductors were accordingly rearranged, and the center wire of each circuit was dropped on to a new cross-arm fixed lower down, which gave the wires the proper triangular disposition with a distance of 36 inches between them. An 11,000-volt arc would not hold at this distance, while the lodgement of pieces of wire is, with such centers, rendered very unlikely.

The distance between the wires

should never be less than 24 inches for any voltage. In the 13,000-volt line of the Milano-Verese Railway, the wires are 20 inches apart, while in the Paderno-Milan 14,000-volt line and the Apple River-St. Paul's, 25,000-volt line they are 24 inches apart. So far as pressures up to 20,000 volts are concerned, it is evident that a spacing of 24 inches is quite sufficient, but if the lines are likely to be interfered with by evilly disposed persons, this distance may with advantage be increased to 36 inches. Statistics of installations show that this last dimension need not be exceeded until the pressure is above 30,000 volts, while for 40,000 volts 48 inches is about the right thing.

Up to the present, there has been no rule for the distance apart of the wires, as every engineer, guided possibly by local circumstances, has spread the wires according to his own views. In the first 40,000-volt installation, for instance, the wires were spaced no less than 9 feet apart; in a later installation the distance for the same pressure was reduced to 3 feet 6 inches. The Washington Water Power Company recently put up a line 100 miles in length, to operate ultimately at 60,000 volts, in which the wires were spaced only 3 feet 6 inches apart. This certainly seems very close spacing for such a high pressure, and in this respect it stands alone amongst the newer installations.

The spacing on the new lines of the Missouri River Company, the California Gas & Electric Corporation and the Guanajuato Power & Electric Company is in accord with what experience dictates. On these lines the distances between the wires are 6 feet 6 inches, 6 feet, and 6 feet 7 inches, respectively, the working pressures being 57,000 volts for the first, which is 65 miles long, and 60,000 volts for the last two. In the new line of the Shawinigan Water & Power Company, which is operating at 53,000 volts over a distance of 84 miles, the spacing between the wires is 5 feet.

The new schemes are fairly consistent, and, generally, it is found that the distance between the wires in feet is about equal to the working pressure in volts divided by 10,000. Now that we have sufficient data at hand, it would be well to adopt a general rule for the spacing, thus doing away with the needless and useless variations from the average. To this end the writer proposes that a uniform standard spacing be adopted of 1 foot for every 10,000 volts pressure with a minimum spacing of 2 feet. According to this, a 60,000-volt transmission would have the wires spaced 6 feet apart; a 50,000-volt, 5 feet, and a 40,000-volt, 4 feet. For 20,000 volts the standard spacing would be 2 feet, which might be increased to 3 feet if the lines were likely to be tampered with, but 2 feet would be the minimum for any lower voltage.

The Largest Windmill in the World

According to "The American Inventor," the largest windmill in the United States, if, indeed, not the largest in the whole world, has recently been constructed near San Francisco, Cal. It is located directly on the ocean beach, near the famous "Seal Rocks," and is used for pumping water up into Golden Gate Park to aid in furnishing the general supply.

The wooden tower supporting the wind-arms rises 150 feet. It is 40 feet square at the base, very securely anchored, and gradually tapers upwards, assuming a round shape. There are four immense wooden arms, or vanes. Each arm measures 80 feet from the center or hub, thus making a diameter of 160 feet in describing the circle. The wind-vanes are 6 feet wide, and extend nearly the entire length of the huge arms, thus affording the greatest possible amount of wing space for catching the air.

This windmill is located upon a prominent elevation, so that it may catch every available wind. It is capable of developing about 50 horsepower—its maximum capacity. Its pumping capacity is 200,000 gallons of water every 24 hours.

The Position of the Electric Automobile

No one who has watched the development of the electric carriage during the last two or three years, says "The Engineering Review," of London, can have failed to note that this type of auto-car has reached a high pitch of mechanical perfection. In congested town areas where high speeds are not possible or desirable, and in circumstances where the limited range of the electric carriage upon one charge of its accumulators is no disadvantage, it is almost perfect as a self-propelled carriage.

Except in the direction of an improved type of accumulator, it is indeed difficult to foresee any further developments. The electric motor itself is highly efficient and elastic. The system of control is simple and effective, and the mechanism transmitting the motion to the road wheels is silent and economical, while the small number of moving parts in the whole machine conduces to a low cost of upkeep.

The battery question is not as difficult a problem as writers on the subject in the past would lead one to suppose. It has been usual to blame the accumulator when anything went wrong, but bad financial methods and false aims have combined to act as a more powerful brake on the development of the electric carriage than the absence of the perfect accumulator.

Generally speaking, a plate that is cheap and fairly durable will give better commercial results than an expensive plate with a longer life. The lead plates in use to-day give from 10 to 12 watt-hours per pound. The battery usually forms about 33 per cent. of the total weight of the carriage. At speeds varying from 12 to 15 miles an hour, a distance of from 35 to 40 miles is obtained upon one charge of the batteries. Such a range is amply sufficient for most purposes of an urban area. Where longer distances are required, a system of interchangeable batteries is adopted.

The Edison or Junger nickel-iron batteries have not been tried a sufficiently long time for any opinion to be given as to their future commercial value in connection with electromobiles. Certain serious disadvantages attend their use. The electrolyte—caustic potash—is a rather more objectionable material to deal with than is sulphuric acid. As far as can be judged, quite as much expert attention will be necessary as the lead battery now requires. The voltage is so low that 70 cells will have to be used where 44 now suffice, while the relation of bulk to capacity is entirely in favour of the lead battery. At present the cost of the nickel-iron cell renders it almost prohibitive, and very full proof of its durability will have to be produced to warrant the heavy capital outlay which will be entailed by its adoption.

It is true that the cost of keeping and maintaining an electric carriage has, up to the present, been high. Not only are the existing garages in expensive neighbourhoods, but manufacturers have been obliged to charge such a figure for maintenance as would provide for all risks of mechanical replacements. It may, however, be confidently stated that the experimental and expensive days of the electric carriage are passed. The machines have proved themselves not

only unrivalled as town carriages, but also remarkably reliable owing to the system of periodical expert examination possible under the garage system. As the number of garages increases, particularly in less expensive quarters of the town, and as costs are reduced by the elimination of weak mechanical elements, and parts which are expensive to maintain, so will the expense of upkeep be reduced.

The manufacturer of the electric carriage has derived an enormous advantage from his courage in undertaking the maintenance of his own machines. He actually knows what they cost to maintain, and every improvement that he has introduced has been made with a view to reducing the cost of upkeep. Cost of maintenance rather than first cost has been his leading motive, and the result has been the production of a machine whose running costs can be guaranteed with that confidence which can alone be derived from reliable data accumulated over a considerable period of time. It may be accepted as an axiom that the town carriage of the future will be the vehicle which costs least to run and maintain, and which will keep in running order during the largest number of years. More especially will this be so in the case of the trade vehicle. The man who thinks of buying a van for trade purposes does not consider so much the first cost as he does his annual balance sheet, and unless he can be offered proof that his expenses will be reduced by adopting motor traction, he will certainly keep to his horses.

The cost of running an electric carriage or van will be found to compare very favourably with the cost of running any other type of vehicle. Admitting that the electric carriage is of such a simple character that a man can safely be placed to drive it without any previous mechanical training, and considering the ease with which a large number of electric vehicles can be economically and efficiently garaged in a single depot, it may safely be assumed that it will find a prominent place in the solution of the question of urban traffic.

An Electric Laboratory Furnace

THE furnace commonly used in the chemical laboratory consists of a porcelain tube heated externally by gas flames, and through which the gases to be burned are passed. The life of the tube is short, generally lasting for but one determination. Prof. H. W. Morse, of Johns Hopkins University, has, according to "The Engineering and Mining Journal," avoided this by constructing a simple, cheap and effective electric furnace out of materials to be found in every chemical laboratory.

He winds a fine platinum wire over the porcelain combustion tube and encloses the heating element thus formed in a larger glass tube. The platinum spiral is heated by an electric current. The gases to be burned are passed in through the porcelain tube, and returning around it are heated by the hot wire. The furnace is easy to manipulate, perfect and quick in action. The platinum wire lasts a long time, and the porcelain tube indefinitely. The furnace not only does its work better than the old type, but is less expensive, both as regards construction and operation.

Accidents Due to Electric Shock

CONSIDERING the magnitude of the electrical industry in all its various branches, and the number of men engaged in connection with railway work, lighting, and power, it cannot be justly urged that the number of fatal accidents due to electrical shock is sufficient to create serious uneasiness either with those engaged in the profession or with the public generally. At the same time, argues "The Electrical Review," of London, it must be admitted that as such accidents are becoming more frequent, it is the duty of the profession to take the initiative in doing everything in its power to protect its members as well as the public.

It is impossible to say definitely what does, or does not, constitute a dangerous pressure; this is demonstrated by the well-known fact that shocks, with good contact, at 2000 volts or over have, with the exception of more or less serious burns, left the victim practically uninjured, while, on the other hand, under somewhat exceptional circumstances a shock of less than 200 volts has proved fatal.

All unskilled men should be rigidly excluded from the vicinity of danger, particularly live wires, connections or other parts, or when it is imperative for them to work within the danger zone, they should be placed under the strict supervision of a responsible technical officer. Rules or regulations, however, can do little more than reduce the risk, as numerous accidents are caused by direct disobedience resulting in serious or fatal accident. There is also to be taken into consideration error in judgment or mental aberration on the part of the officer responsible, even when the charge of culpable negligence would be unjust. Cases have occurred where a skilled technical officer has been required to disconnect a cable, transformer, or other apparatus in order to enable a workman to effect alteration or repairs, and has been quite confident that he has done so, but has mistaken the connection and instructed the workman to proceed with his work on a live part, with the inevitable result of an accident more or less serious.

It is not only the technical officer, however, that is at fault; men have frequently disobeyed orders directly and specifically given by their chief, and the only punishment in the power of the latter is to dismiss the offending man, which has but little effect in bringing the remaining staff to a proper sense of their duties, and frequenty does not affect at all the man who fills the vacancy. Many men disregard the rules for their protection, not only after repeated warnings, but after they have suffered more or less severely for their folly. Familiarity breeds not only contempt, but thoughtlessness, and even carelessness, and in this skilled technical men are often culpable with their less accomplished staff. Although accidents to technical men are comparatively rare, they are by no means unknown, and while a feeling of uneasiness and responsibility sometimes engenders nervousness and probable accident, undue confidence, familiarity, or absence of mind are far more liable to result in disaster, and have been the prime causes of accidents of this character.

The question of how to entirely prevent accident, is one that, with a fallible humanity, it is hopeless to consider, but that measures can be taken to largely minimize them is certain, provided it is proceeded with on proper and consistent lines. The whole matter of accidents due to electrical shock should be seriously taken up by a special committee, and powers provided to enable them to obtain evidence upon oath if deemed desirable. From the evidence collected, a valuable set of regulations might be framed, dealing not only with the responsibility of the employer and management, but giving them power to enforce such regulations among their staff, or obtain punishment for their default in a court of summary jurisdiction. A short bill could be promoted for the purpose. In the meantime the following suggestions may not be out of place:—

1. All dangerous or live parts should be enamelled bright red, and

notices prohibiting any unauthorized person coming within 6 or 10 feet (depending upon circumstances) should be printed large and fixed in a conspicuous position.

2. All dangerous or "live" parts should be protected against "accidental contact as far as is consistent with convenient operation, but the operator should on no account be unnecessarily hampered in his work by guards, covers, or fences."

3. No unskilled workman should ever be allowed within the danger zone, and skilled workmen should only be admitted in charge of a technical officer and acting directly under his supervision.

4. The use of rubber gloves should be insisted upon when working within the danger zone,—"whether the parts are 'live' or not,"—and all parts to be worked upon should be efficiently and securely earthed after having been disconnected by a responsible officer.

(N. B.—The portion quoted may occasionally have to be modified, at the discretion of the responsible officer when the parts are "dead" and earthed.)

5. The person required to use rubber gloves should be made responsible for seeing that they are in good condition and should refuse to use them unless they are quite sound.

6. Technical officers must cultivate calmness and presence of mind under all circumstances, and ever remember that not only their own lives but the lives of their staff are largely in their care.

7. Instant dismissal should in every case follow a deliberate breach of the regulations.

8. Frequent first aid and resuscitation drill should be practiced by as many officers and members of the staff as possible.

The Galbraith Electric Iron and Steel Furnace

WHILE electro-metallurgy cannot, on the whole, be said to be advancing at an accelerated rate, the electric smelting of iron and steel is regarded as hopeful. Nobody, says "Engineering," of London, desires to replace the blast furnaces, where iron ore, coal and limestone occur in convenient proximity, by electric furnaces; but where water power is available, and blast-furnace coke is not, electric smelting may be commercially successful. Further, steel, equal, it is alleged, in all respects to the best Sheffield crucible steel, can be produced in electric furnaces at considerably lower costs. There is an ever-increasing demand for rich alloys, ferro-chromes, ferro-silicons, ferro-tungstens, etc., which can be prepared only in the electric furnace. Several types of electric iron furnaces may be distinguished. In the induction furnace of Kjellin the iron, contained in an annular groove, forms the secondary of a high-frequency circuit, whose primary coil surrounds the groove; only high-class materials are applied, and an excellent steel is produced, but the efficiency is not high. As there are no electrodes, all possibility of contamination of the metal by the impurities in the electrodes is excluded. Stassano utilizes only the radiated heat of arcs playing above the fused mass.

Héroult, Keller and others let the electrodes dip into the slag, but not in the fused metal. There is, therefore, no contamination either, and a very good steel is produced. Héroult was really the first who brought electrically prepared steel on the market. Some of the furnaces of this latter type may be classed both as arc and as resistance furnaces.

The Ruthenburg furnace so far represents a type of its own. The object is to melt magnetic iron sand, difficult to deal with in ordinary furnaces, into beans suitable for further treatment, while at the same time eliminating some of the impurities. At Messrs. Cowles works, at Lockport, N. Y., Ruthenburg has for some years experimented with two slowly revolving water-cooled cylinders, serving both as magnetic poles and as electrodes for currents of 500 amperes at 100 volts. The ore, held in the narrow gap between the poles by magnetic attraction, is melted by the current, drops into a pit, meets reducing gases on its way, and is found in the shape of beans, which, it is claimed, have lost most of the sulphur and phosphorus of the ores.

The report of the commission, consisting of Dr. Haanel, C. E. Brown and F. W. Harbord, which studied the various electric iron processes on behalf of the Canadian Government, is, however, not favourable to this process. It is pointed out that the ore loses its magnetism just before melting, and that neither an effective agglomeration, nor a reduction of the fine material, is obtained.

A successful treatment of iron sand would be an important step in advance. Iron sands abound in many localities. The term is used both for grainy magnetite—a combination of iron oxides corresponding more or less to the formula Fe_3O_4—and for the ore known to the mineralogist as menachanite (from Menachan, in Cornwall), and by other names, an oxide of iron and titanium, with 30 and more per cent. of the latter. Both the ores are either too compact for direct reduction, or so finely divided that they trickle through the furnace, and most attempts to transform these ores into briquettes have failed. Gröndal and Mathesius are said, however, to have succeeded, each in his own way, in making suitable iron-sand briquettes. In any case, however, the new process which the Galbraith Iron & Steel Company, Ltd., of Auckland, New Zealand, demonstrated at the Brush Electrical Engineering Company's works, at Loughborough, Leicestershire, a few weeks ago, would deserve close attention. The main features of this process are the following:—

The iron-sand, mixed with carbon, is passed through a furnace so as to fall as a shower in a zigzag path through a number of carbon grids heated by the current, until, melted and reduced, it arrives in the receptacle below. The whole furnace is sealed and open only at the feed-hole above, so that no air can enter, otherwise the grids, or incandescents, as the inventors, Messrs. J. K. Shirreff Galbraith and William Steuart, call them, would be burned. The charge is further met on its downward path by reducing gases. Low-potential currents are utilized. Neither flux nor fuel, in the ordinary sense, is needed, and the iron or steel, which collects in the receiver in the shape of beans, is said to be free of the titanium contained in the ore. An admixture of 1 per cent. would not be objected to by metallurgists in most cases; often a higher percentage of titanium could be tolerated, and for certain steels some titanium is considered a desirable constituent.

The raw material comes from Taranaki Bay, in New Zealand, where it covers miles of the beach. This iron-sand has, so far, practically no value, and if the inventors do not accomplish more than to transform the very fine black powder into beans suitable for Bessimerizing or other treatment, they will have achieved an object on which vast sums have, so far, been spent in vain. The fine sand is passed through magnetic separators. It is very pure, and the impure and purified ore shown differed hardly in appearance. Analyses are here given of the ore and of the steel resulting from another less pure sample of ore taken from a breakwater:—

	Ore Per Cent.
Peroxide of iron	67.04
Protoxide of iron	30.17
Manganese peroxide	0.22
Aluminium oxide	0.16
Silica	0.50
Calcium and magnesium, traces	....
Titanium	1.6
Undetermined	0.31
	100.00

	Steel Per Cent.
Carbon by combustion	2.685
Silicon	0.201
Sulphur	0.189
Phosphorus	0.453
Arsenic	Nil
Manganese	0.137
Copper	0.24
Iron	96.095
Titanium	Nil
	100.00

The titanium percentage may rise to 4 per cent. The titanium is supposed to pass into the slag, but there are hardly any constituents to form a slag with. The ore was supposed to be free from phosphorus; the material just now worked on does, however, contain some phosphorus.

The ore is mixed with coal dust and heated, for a few minutes only, in a crucible. This roasting, or preheating, would, in a commercial plant, be performed in a rotatory kiln or in some other less primitive way. The furnace itself is built up of a framing of graphite, holding horizontal grids, likewise of graphite; the grid-bars form obtuse-angled roofs. Four of these grids are confined in one tier, and three tiers are arranged above one another, so that the charge shower falls, in descending, over 12 bars in succession, and, finally, into the receiver—an iron box—below. Between the bars, or incandescents, interceptors are to be placed; these interceptors are of the same shape as the incandescents, but they are not so thick, and their bars are closer together. In this demonstration furnace only one interceptor was used, at the very top of the furnace; through this interceptor grid the charge trickled down in three streams. The incandescents and interceptors are made by the Morgan Crucible Company, of Battersea.

Each incandescent, it will be understood, forms a rectangular horizontal frame against the front, in the back of which iron bars are pressed. In the furnace which formed the subject of the recent experiment, a good contact between the front and the iron was secured with the aid of weighted levers; this pressure forced the backs of the grids against the bars at the back. The current leads, copper bars, or ribbons, were screwed to the iron; there were 12 circuits, 1 for each grid. Mr. Gardner, who assisted in the experiment, put in about a pound of charge per minute, and a current of 100 KW. at 18 volts was stated to be used. The waste of power and heat in this skeleton furnace was, of course, great. But furnaces of this type are to be constructed with walls of bauxite, and it should be possible to cool the electrodes with the aid of water jackets. No figures as to the economy of the process can be given under the circumstances. Through peep-holes, closed by mica, the metal could be seen to trickle down into the receiver in big drops, which united to ordinary size beans, and further fused together, as the receiver was not cooled. Specimens of steel obtained in the furnace were exhibited.

The Heat of the Sun

THE earth receives less than the one two-billionth part of the heat radiated by the sun. Although the sun must be losing a tremendous amount of energy all the time, there is no historical evidence, says "The Iron Age," that it is any cooler now than it was 2000 years ago. It must have some source of heat other than that due simply to incandescence, since in the latter case it would have lost to an appreciable extent during times of which we have record. The astronomer, R. S. Ball, says that it would take 20 tons of coal burned every 24 hours on every square foot of the sun's surface to maintain its heat. How, then, is the action of this great furnace to be explained? Meteors falling upon the sun will not answer the question, because the quantity is insufficient.

The nebular theory advanced by Laplace goes far toward solving the problem. Every heated body contracts when cooling, and in the contraction generates heat. Therefore, while the sun is constantly losing heat by radiation, it is gaining heat by the reduction of its bulk. By this double action the rate of cooling is reduced.

But we now have an entirely new theory evolved by a scientist whose work commands most serious attention—George Howard Darwin, professor of astronomy and experimental philosophy at Cambridge University. A few days ago he delivered an address at Johannesburg, South Africa, before the British Association, on "Celestial Evolution." Calculations based upon the constituent elements of the sun, as revealed by the spectroscope and their action, had led physicists to believe the age of the solar system to be less than 20,000,000 years; geologists have made the period between 50,000,000 and 1,000,000,000 years. Prof. Darwin made the statement that recent researches in physics had shown that the heat of the sun might be produced by other causes than the simple concentration of matter. Radium is vastly more powerful than dynamite, and 22 ounces of it would be sufficient to propel a 12,000-ton ship twice across the Atlantic at the rate of 15 knots per hour. The sun is radio-active, and its tremendous energy may be explained by the new discoveries. At any rate, our knowledge of these substances and of their action, while in no way conflicting with accepted theories, enables us to bridge important gaps. The study of the action of radio-active elements is of but recent origin. Should future examination bear out the conclusions so far reached, the life of the sun, past and to come, will be vastly extended, and we may surely expect the manifestation of its energy for periods of time beyond our comprehension.

Electricity in a Cathedral

AN interesting account of the extent to which electricity is made use of in the new cathedral that was inaugurated in Berlin a short time ago, is given in "The Electrical Review," of London. The installation includes a complete electric light and power plant, installed by the Allgemeine Elektricitäts Gesellschaft, and connected to the mains of the Berlin Electricity Works.

The vestibule is lighted by arc lamps, as is also the main cathedral. Indirect illumination is secured by arranging the arc lamps in hidden places above the cornices in the main cathedral, on the galleries of the cupola, which by reflectors distribute uniformly throughout the vast hall the beams of light, softened by diaphragms. These effects are added to by illuminants of the same kind, throwing their light upwards from magnificent candelabra placed in the aisles, and preventing the formation of any disturbing shadows. With the light of these arc lamps, softly diffused from the roof, is mixed that of hundreds of glow lamps mounted on the same candelabra, as well as on brackets and chandeliers.

Nernst lamps have also been used in the cathedral, shining in 52 candles from the altar niches, and filling with their soft glow the vaults of the Hohenzollern crypt.

The electric lighting plant of the cathedral, throughout its halls and even outside the church proper, includes at present about 1900 glow lamps of 15 to 25 normal candle-

power, upwards of 100 Nernst lamps, and about 70 arc lamps of 6 to 15 amperes.

Power is supplied by six electric motors, one of 10 H. P. actuating the organ blowers, while two 9-H. P. motors are set apart for the bell work, and the remainder for fans and a lift. The organ motor works at 1175 R. P. M. on a high-pressure blower, and is actuated by a starter placed close to the keyboards.

The mechanism employed to ring the three bells of the cathedral is especially noteworthy. It consists of a long electrically-driven shaft to which three discs have been firmly keyed, each corresponding to one of the bells. Beside each of these discs is placed a loosely running drum carrying the end of the ringing rope. The drum is pressed by a special mechanism against the rigid disc, so as to partake of its motion, when the rope being wound up will actuate the bell. The same mechanism afterwards separates the disc and drum, so that the rope being wound off can follow the swing of the bell to the other side. This alternate throwing in and out results in the bells giving out their powerful sounds.

The Allis-Chalmers Steam Turbine

THE recent starting up of a steam turbine at the Washington street power house of the Utica Gas & Electric Company, of Utica, N. Y., calls attention to the fact that this is the first turbine to be put into operation by the Allis-Chalmers Company, of Milwaukee, Wis., who recently entered the steam turbine field.

Fig. 1 shows the turbine unit installed. The turbine is rated at 1500 KW. normal load, and runs at a speed of 1800 revolutions per minute. It is direct coupled to an Allis-Chalmers two-phase, 60-cycle, revolving-field alternator, operating at 2500 volts. The unit has a continuous overload capacity of 25 per cent., with a three-hour, 50 per cent. overload capacity without exceeding a safe generator temperature, and is capable of a 100 per cent. safe momentary overload. Artificial ventilation by means of an electrically-driven fan blower will, however, enable the unit to be run safely beyond its rated overload capacity.

The turbine follows the well-known Parsons type, which has proved itself eminently successful in numerous installations both here and abroad. The Allis-Chalmers construction, however, embodies a number of features which are new in this country, and which are claimed by the builders to be distinct improvements. The chief distinguishing feature of this construction is the blading, which, while it is of the Parsons reaction type as regards the principle of operation, differs in mechanical construction in a number of essential details.

As will be seen from Fig. 4, the roots of the blades are formed in dove-tail shape by special machinery, and are inserted in slots cut in foundation or base rings, the slots being formed by special machine tools in such a way as to exactly conform to the shapes of the blade roots. The foundation rings themselves are of dove-tail shape in cross section, and are inserted in dove-tailed grooves cut in the turbine cylinder and spindle, respectively, in which they are firmly held by key pieces, much in the same way that the well-known "Lewis bolt" is fastened. In order to further insure the integrity of the construction, the key pieces or rings, after being driven into place, are upset into undercut grooves.

Another noticeable feature of the blading is the method of reinforcing and protecting the tips of the blades.

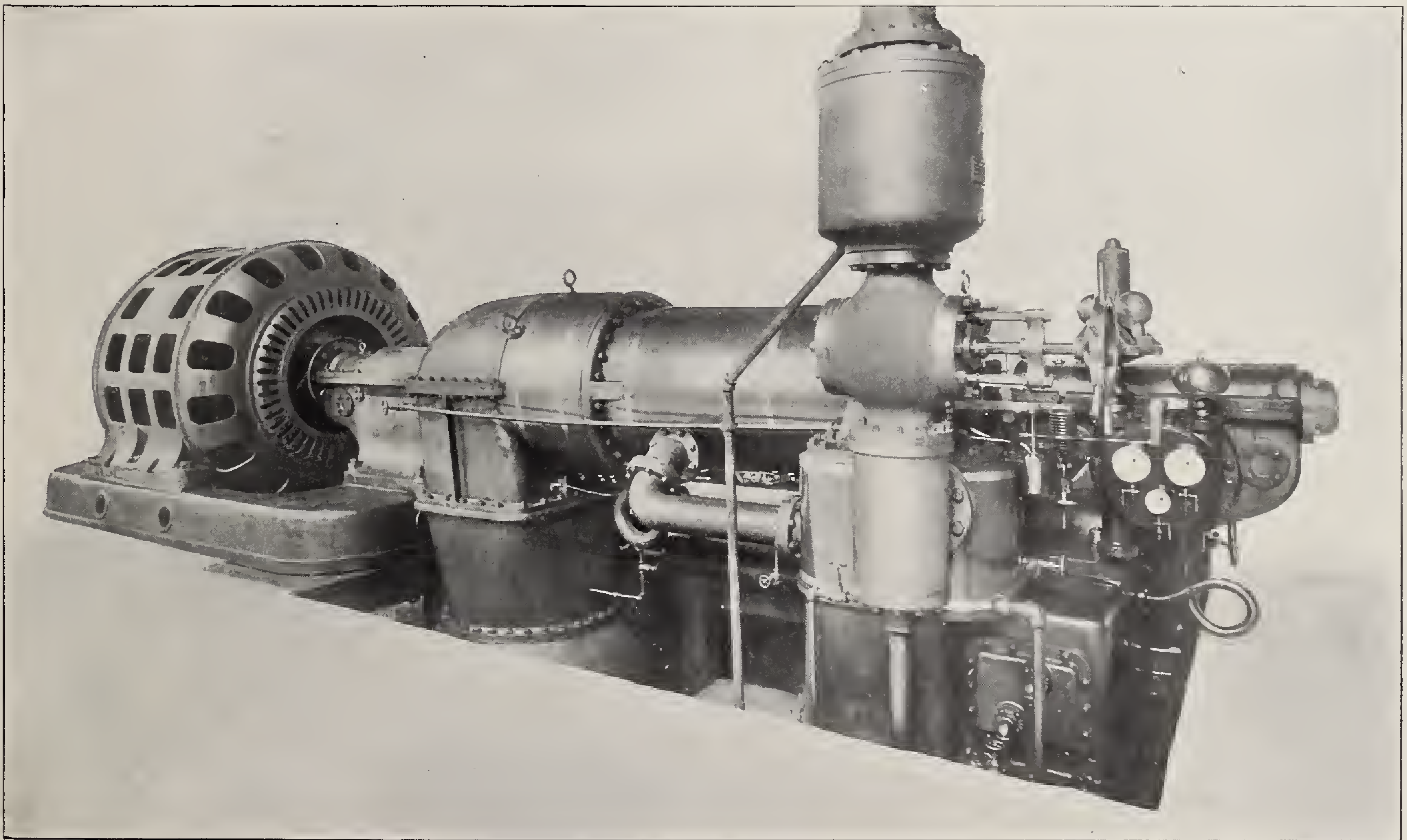


FIG. I.—A STEAM TURBINE GENERATING UNIT BUILT BY THE ALLIS-CHALMERS COMPANY, MILWAUKEE, WIS., FOR THE UTICA GAS & ELECTRIC COMPANY, UTICA, N. Y.

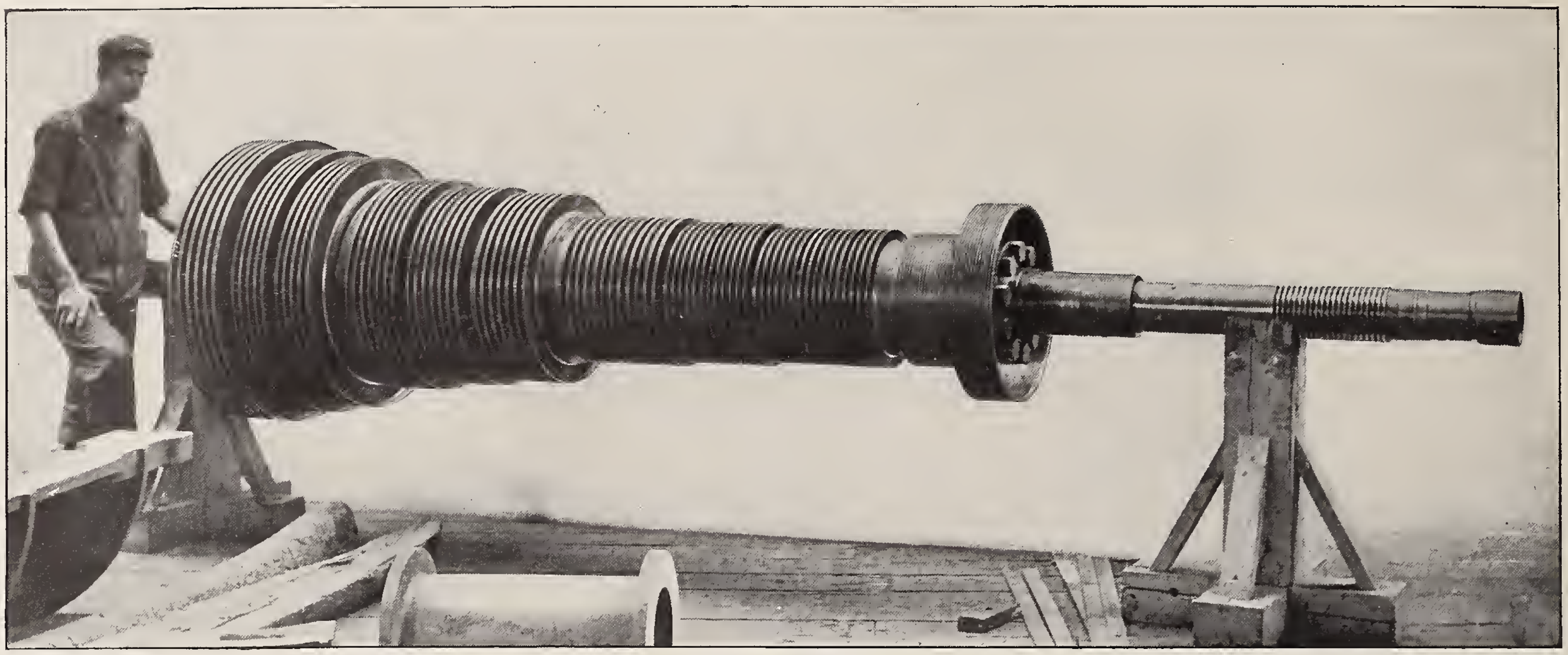


FIG. 2.—THE STEAM TURBINE SPINDLE WITH BLADING ASSEMBLED

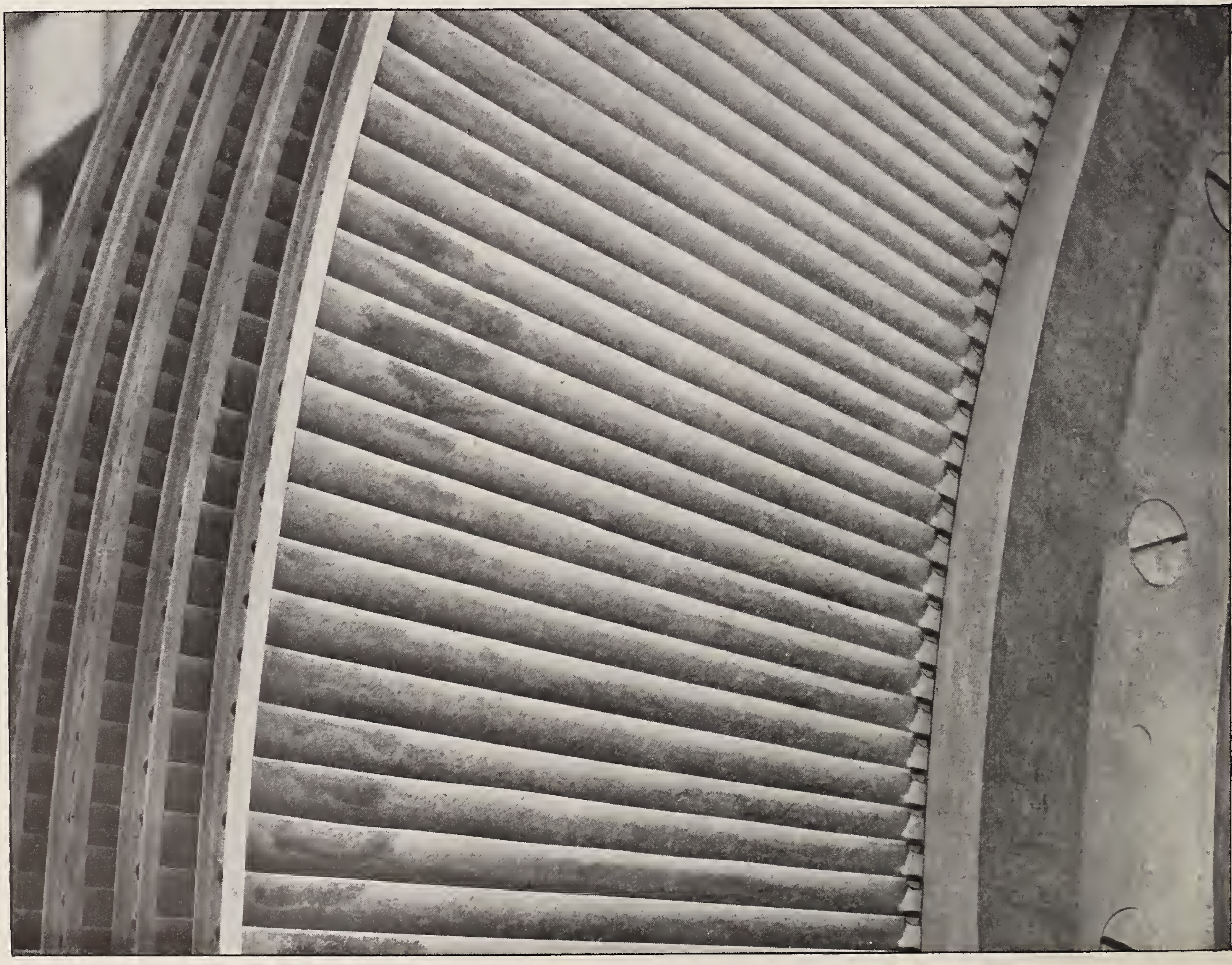


FIG. 3.—A PART OF THE BLADING OF THE ALLIS-CHALMERS STEAM TURBINE

This point in steam turbine design is one upon which much thought has been expended by various inventors, and the Allis-Chalmers Company claim that the construction employed by them successfully solves all difficulties. In forming the blades a shouldered projection is left at the tip. This is inserted in a slot punched in a shroud ring, the slots being punched by special machinery in such a way as to produce accurate spacing and at the same time form the slots so that they will give the proper angles to the blades independently of the slots in the base ring. After the blade tips are inserted in the slots in the shroud rings they are riveted over by specially arranged pneumatic machinery.

The shroud rings are made in channel shape, with outwardly projecting flanges, which, after assembly in the turbine, are turned and bored to give the necessary working clearance. The flanges of the channels are made so thin that, although amply sufficient for stiffness, the shroud ring does not have the disadvantage of a solid shroud, which acquires a dangerous temperature by friction in case of an accidental contact of the rotating and stationary parts. It is claimed for this construction that the blades are stiffened against the effect of vibration in a much more substantial manner than by any other means thus far employed, while the use of a protecting shroud ring enables the working clearance to be made smaller than in the case of naked blade tips, without danger in case of accidental contact, thus reducing the leakage loss to a minimum, the leakage past the blade tips being the principal source of loss in the steam turbine. As to the safety from damage in case of accidental contact, it is claimed that this has been proved by experiment with actual blading, by throwing the bearings out of center so as to produce contact, without detrimental results. An incidental advantage claimed for this construction is that if by chance a blade should prove defective, it is so held in place by the shroud ring that it cannot possibly work loose and produce damage.

By the method of construction described, the entire blading is produced by machinery, thus eliminating the personal equation entering into hand work. It makes certain that every blade is securely fastened, and all blades are necessarily set at exactly the designed angle and pitch; the openings between blades, upon which in great part the economical performance depends, are absolutely uniform. The blading is made up in half rings in the blading shop, and is carefully inspected before being inserted in the turbine.

Fig. 3 is a view of the blading, showing the substantiality of the construction as well as the uniformity of the work. Fig. 2 shows a turbine spindle of the same size as that of the Utica turbine, the photograph having been taken in the West Allis shops of the Allis-Chalmers Company.

Another special feature of this turbine will be noticed by referring to Fig. 2, viz., the absence of the usual low-pressure "balance piston," the illustration showing only two balance pistons instead of the three pistons formerly used in this type of turbine, in which it is said to have been found difficult to produce a balance piston of the size required for balancing the low-pressure stage of the turbine and at the same time make it sufficiently rigid to run with the necessary small working clearance.

In the Allis-Chalmers construction there is, however, a third balance piston, but instead of being at the high-pressure end of the turbine, as formerly arranged, it is at the low-pressure end, and as it is smaller than the large end of the spindle, it is hidden from sight in the photograph. By making this piston in such a way that its circular area is equal to the annular area of the pistons used in the older construction, the low-pressure balance piston is made much smaller. Instead of reducing the leakage past this piston by means of "dummy packing," as in the high-

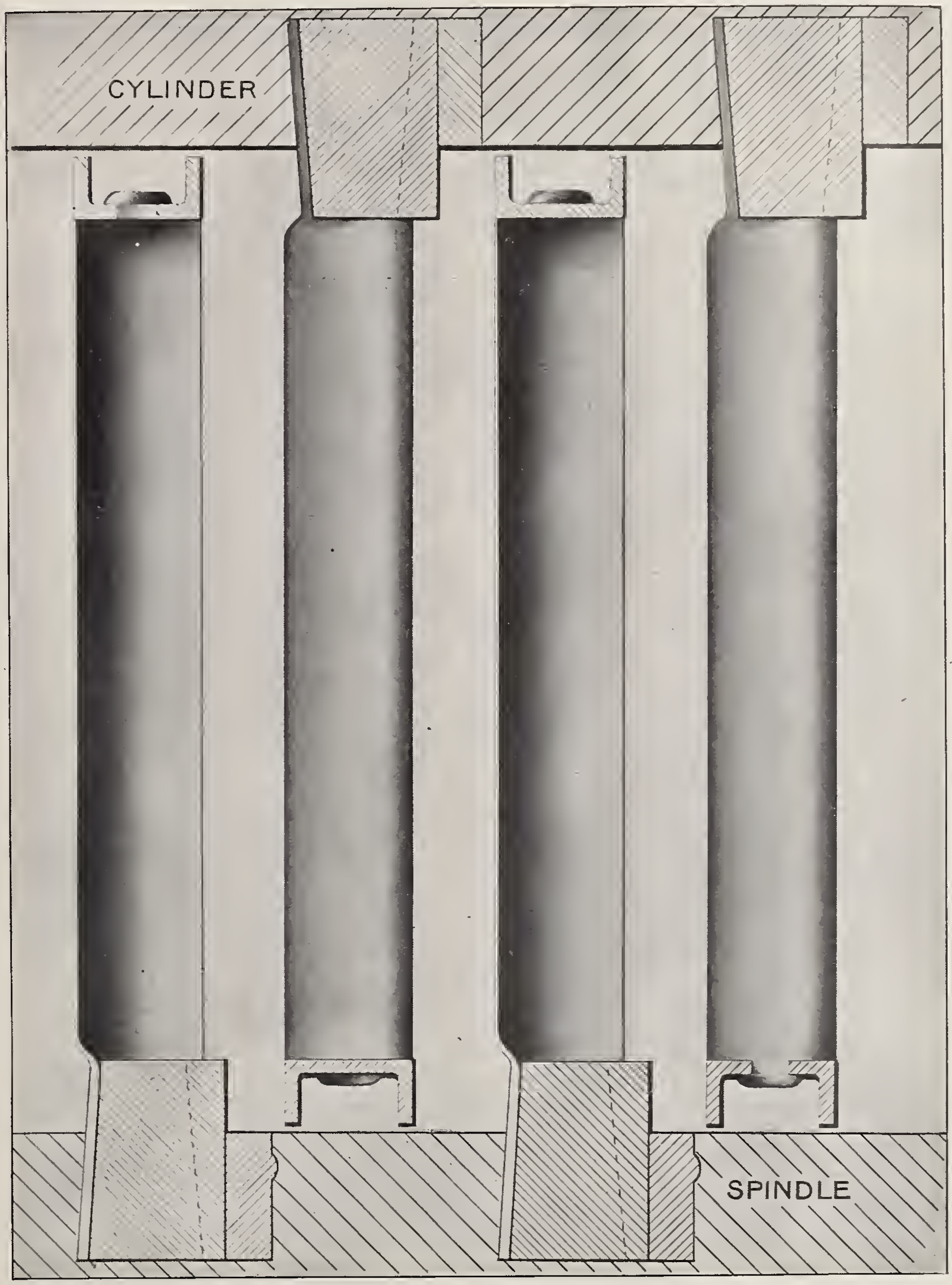


FIG. 4.—CROSS-SECTION OF THE SPINDLE, BLADES AND CYLINDER OF THE ALLIS-CHALMERS STEAM TURBINE

pressure and intermediate pistons, and as used in the low-pressure pistons of the older construction, a labyrinth packing of radial baffling type has been adopted, thus eliminating small axial clearance in this turbine. A considerable advantage is claimed for this construction in permitting the use of smaller working clearances in the high-pressure and intermediate balance pistons.

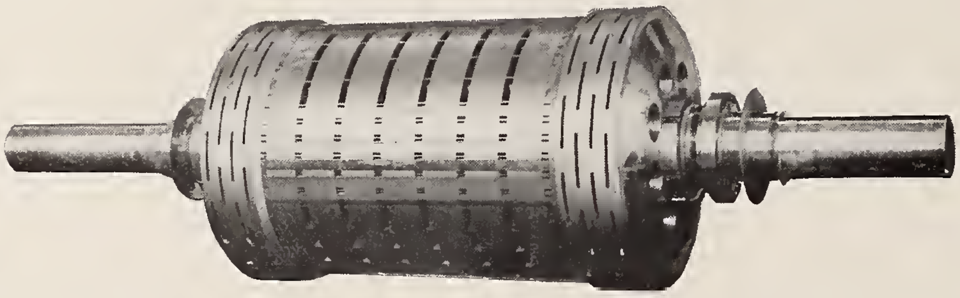


FIG. 5.—THE REVOLVING FIELD OF THE GENERATOR

The alternating-current generator of the Utica outfit also deserves some attention. Perhaps the most noticeable feature of this generator is the substantial design of the revolving field, illustrated in Fig. 5, providing great strength and at the same giving the thorough ventilation which is essential. Particular attention has been paid to the insulation, as may be inferred from the fact that the armature was subjected to an alternating-current insulation test of 10,000 volts for the period of 15 minutes. This generator was built at the Bullock works of the Allis-Chalmers Company at Cincinnati.

The Allis-Chalmers Company, in entering the steam turbine field, effected an alliance with the Turbine Advisory Syndicate of England, thereby securing the co-operation of the firms interested in it, including Messrs. Willans & Robinson, the famous high-speed engine builders, of Rugby; Yarrow & Co., the well-known torpedo boat builders, of the Isle of Dogs, London; and the Neptune Shipbuilding Works, of Walker-on-Tyne. The Utica turbine, in fact, was built for the Allis-Chalmers Company by Messrs. Willans & Robinson, to whom a number of turbine contracts were sub-let by the Allis-Chalmers Company before the latter had perfected the installation of their special machinery for turbine manufacture. An agreement has more recently been effected with Hon. Charles A. Parsons, C. B., for interchange of data, thereby giving to the Allis-Chalmers Company the benefit of the vast experience of Mr. Parsons, the original inventor of this type of turbine, and to whose engineering ability and indomitable energy the evolution and present state of perfection of the successful steam turbine are principally due. The Allis-Chalmers Company have also secured rights under Mr. Parsons' patents for marine turbine and turbo-compressors and blowers, for which there is a growing demand.

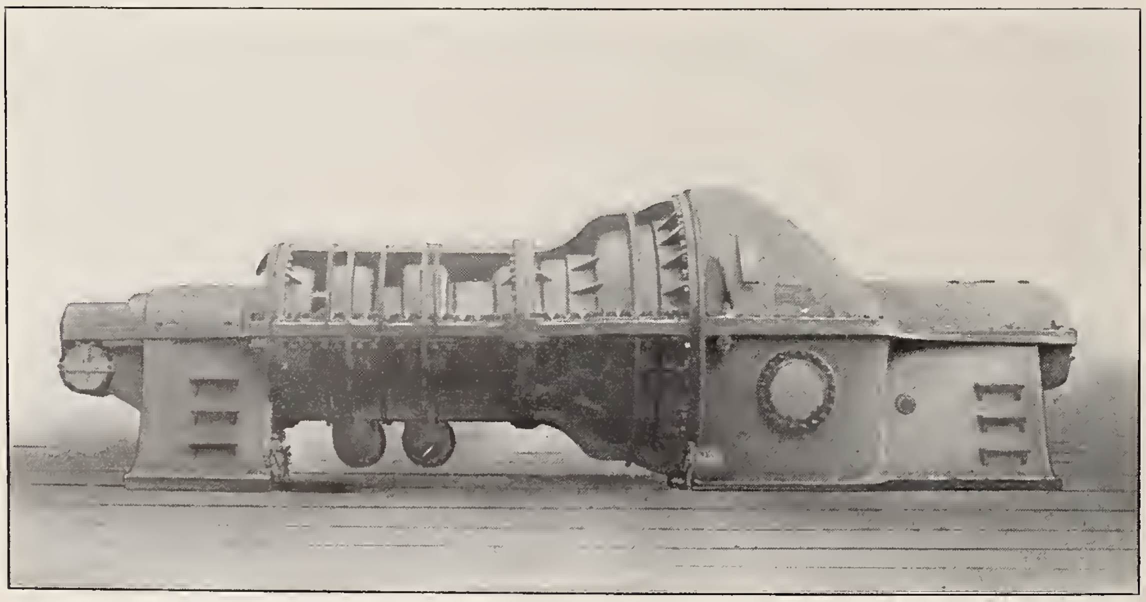


FIG. 6.—A 9000-HP. STEAM TURBINE BUILT BY THE ALLIS-CHALMERS COMPANY FOR THE BROOKLYN RAPID TRANSIT COMPANY'S NEW POWER HOUSE

At present the Allis-Chalmers Company are building their steam turbines in their engine works at West Allis. The growth of the business, however, has led to a large extension of the works, amounting to a practical doubling of the present plant. A considerable part of the extension will be devoted to the manufacture of steam turbines and the accompanying electric generators, one of the three new manufacturing buildings being given up to the exclusive manufacture of the turbines themselves. The first steam turbine of the Allis-Chalmers Company's own make, of 5500-KW. capacity, was recently shipped, and others are following as fast as the present crowded condition of the shops will permit.

Another turbine installation is for the Brooklyn Rapid Transit Company at its new Williamsburg station erected near the bridge of that name, and designed to accommodate a total of nine steam turbine and generator units, three of which are now being installed. One of the most interesting of these is the Allis-Chalmers 9000-H. P. unit shown in Fig. 6.

The turbine operates at 750 revolutions per minute. The generator is a Bullock alternating-current machine, built by the Allis-Chalmers Company at its Cincinnati works. It will carry 25 per cent. overload continuously at 50 per cent. overload for three hours with but small temperature rise.

On the occasion of the visit on December 6 of the American Society of Mechanical Engineers to the works of Henry R. Worthington, at Harrison, N. J., the company presented each visitor with a souvenir pamphlet containing a portrait and a short biography of the founder and a description of the works, with numerous views showing parts of the plant, some of the special machines, and pumps, meters, condensers and pumping engines built by the company. The first Worthington pump, built in 1841, is also illustrated. The pamphlet is attractively bound in light blue, with the society's emblem embossed in gold and dark blue on the cover.

A process for rolling old rails into ties is an innovation brought out by the York Rolling Process Company, of New York. It is claimed that almost any desired section can be made from either the head or bottom flange, no matter how badly worn or unsymmetrical the scrap stock may be.

Anthony Comstock (rushing into an electric light office):—

"Where is that naked wire?"

The office boy faints.

Electrical and Mechanical Progress

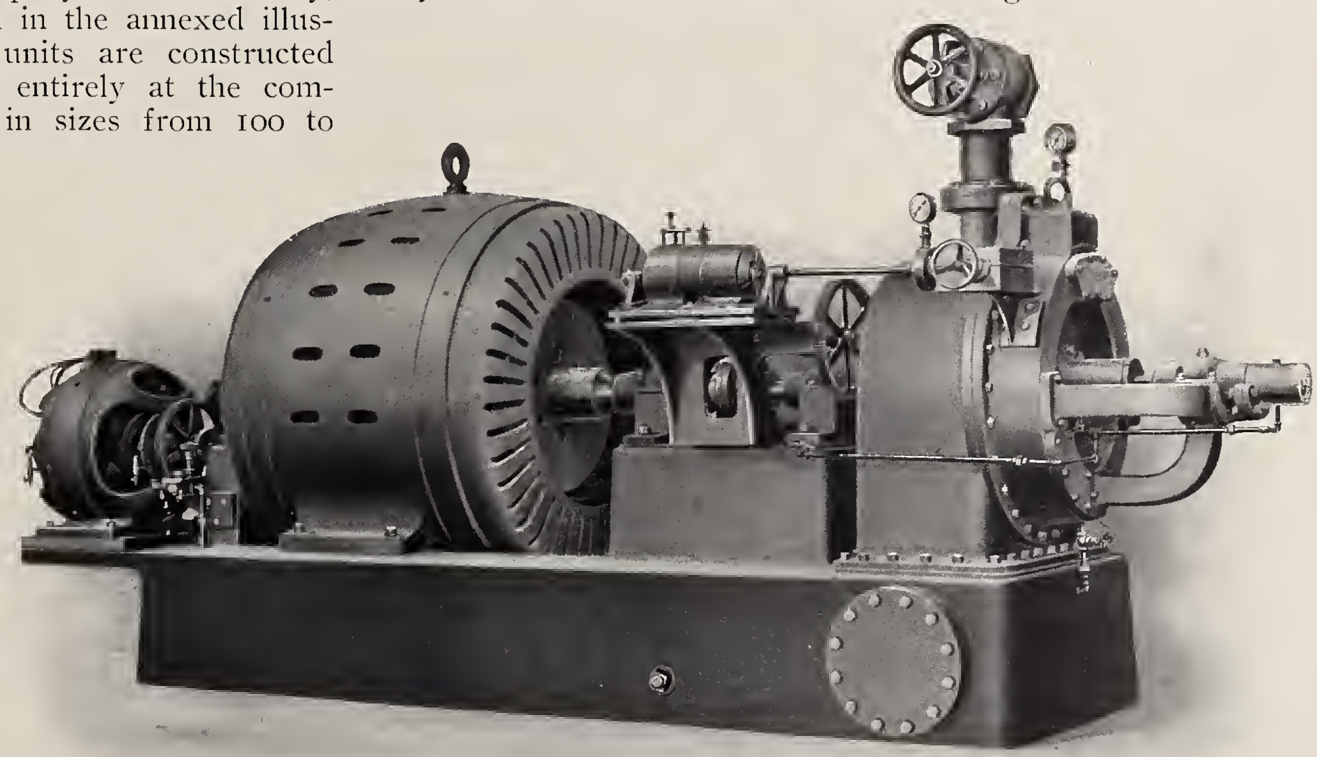
A New Steam Turbine Alternating-Current Unit

A NEW steam-turbine alternating-current generating set built by the Warren Electric Manufacturing Company, of Sandusky, Ohio, is shown in the annexed illustration. The units are constructed and assembled entirely at the company's works, in sizes from 100 to 3000 KW., and in speeds from 3600 to 600 revolutions per minute, without any gearing in the main drive.

The turbine consists essentially of a ring carrying expanding nozzles, revolving discs carrying vanes and stationary rings with deflecting vanes. The principle employed is that of expanding the steam in the nozzles and fixed vanes, transforming the energy due to pressure into velocity.

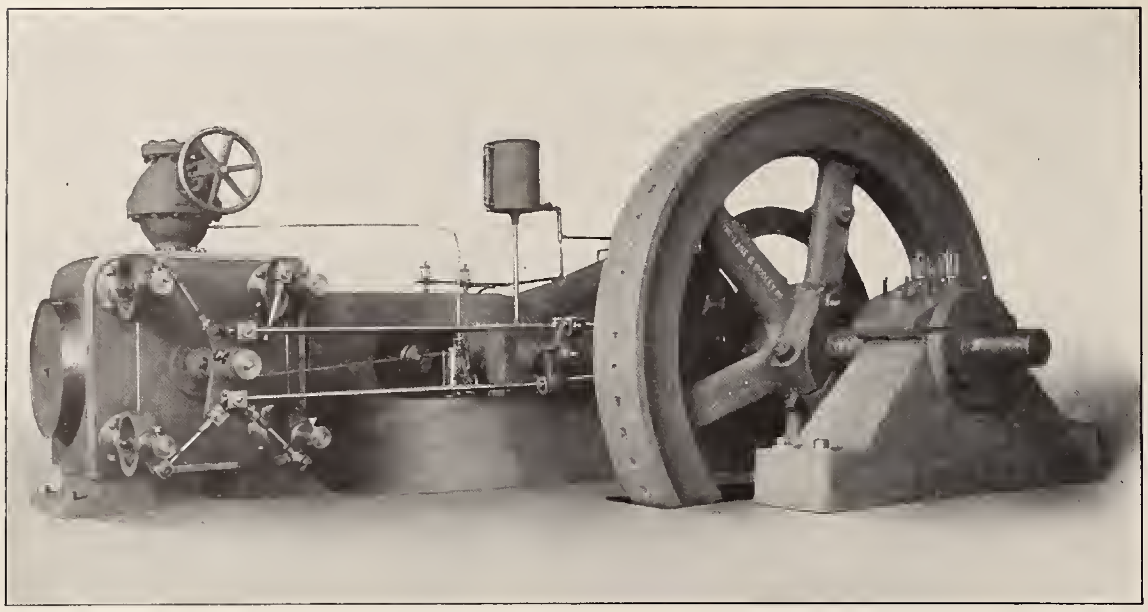
The revolving discs are of steel, with dove-tailed recesses to receive the drop-forged blades; the latter are smaller on the successive discs as they recede from the nozzle, so as to provide the greater flow area necessary for expansion. In the smaller machines, the nozzles connect with an annular chamber or inner steam-chest, which is connected with the main steam-chest by a series of valves arranged in a circle. In the larger machines, however, each valve opens into a pocket from which two nozzles diverge.

The valves are operated by means of levers connecting with a cam. A ball governor drives a pinion which meshes with the rim of the cam, shifting it so as to open and close more or less of the valves according to the load. Throttling is thus avoided, as those valves which are open always take steam at full pressure.



A 200-KW. TURBINE ALTERNATOR BUILT BY THE WARREN ELECTRIC MANUFACTURING COMPANY, SANDUSKY, OHIO

For single-flow turbines, a special end-thrust bearing is used; but the company also builds a double-flow turbine, in which steam is admitted at both ends and flows to the middle, where it is discharged. With this arrangement no special thrust bear-



A NEW FOUR-VALVE ENGINE BUILT BY THE LANE & BODLEY COMPANY, OF CINCINNATI, OHIO

ing is required. An oil circulation through the bearings is maintained by a pump, and the oil traverses a cooling pipe in a water chamber before reaching the bearings.

A New Four-Valve Engine

THE Lane & Bodley Company, of Cincinnati, have recently placed on the market a series of engines of the four-valve, shaft governor type. These engines are claimed to possess all the advantages found in the high-speed single-valve shaft governor engines, namely, small floor space occupied, high rotative speed and close regulation, with the additional advantage of economy in the use of steam comparable with engines of slow rotative speeds using releasing valve gears. Other desirable qualities claimed for these engines are ability to stand continuously the most severe service, and economy in the use of oil and attendance.

Care has been exercised in the distribution of metal in both frame and cylinder, and a nearly continuous bearing on the foundation is given to these parts.

The valves are unbalanced, rotary, double-ported, placed at the ends of the cylinders, and driven by separate wrist-plates and eccentrics for steam and exhaust. Ample port opening and proper distribution of steam is thus obtained for all cut-offs, while the position of the valves permits of perfect drainage at each stroke and easy inspection of the cylinder.

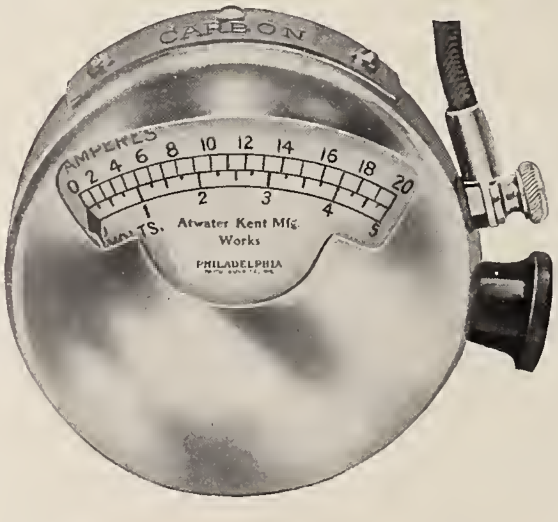
The governor is of the Rites inertia type, and regulates the point of cut-off by changing the travel of the valve, maintaining the proper lead by varying the angle of advance.

A central oil reservoir is provided, mounted on the frame, and piped to all important bearings. The valve gear is oiled by grease cups. All parts throwing oil are enclosed in sheet steel cases, and oil pockets provided for the reception of waste oil arranged to be piped to a filter.

A "Dead Beat" Automatic Volt-Ammeter

IN the automatic volt-ammeter manufactured by the Atwater-Kent Manufacturing Works, of Philadelphia, manufacturers of ignition specialties, a new feature, a "dead beat" needle, has been introduced, which, it is claimed, on account of its quickness in coming to rest, assures a quick and accurate reading.

The meters, one of which is illustrated herewith, are adapted to any work where primary batteries are used. Each meter is guaranteed to be absolutely accurate, hand-calibrated to standardized apparatus and thoroughly tested. A neat, hand-sewed leather case is furnished with each instrument. The prices are:



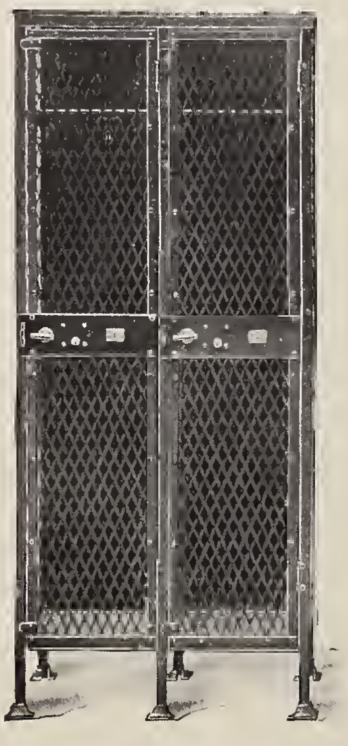
A NEW "DEAD BEAT" AUTOMATIC VOLT-AMMETER MANUFACTURED BY THE ATWATER-KENT MANUFACTURING WORKS, PHILADELPHIA, PA.

0-5 volts, 0-20 amperes, \$6; 0-10 volts, 0-20 amperes, \$7.

The voltmeters, which are the same in appearance as the automatic volt-ammeter, but without button attachment, are also provided with the "dead beat" needle. The prices for these are: 0-6 volt, \$5; 0-10 volt, \$6. The prices of the amperemeter are: 0-10 amperes, \$5; 0-25 amperes, \$6; 0-30 amperes, \$7. Meters with special readings up to 30 amperes and 30 volts are made to order.

Expanded Metal Lockers

THAT the value of steel as a material for interior equipment is fully recognized is shown by the fact that material bins, shelving, filing cabinets, clothes lockers, tables, and the like, formerly made of wood, are now rapidly being replaced by up-to-date steel devices. It is il-



AN EXPANDED METAL CLOTHES LOCKER MANUFACTURED BY THE EDWARD DARBY & SONS COMPANY, PHILADELPHIA, PA.

logical to erect a fire-proof building and equip the interior entirely with wooden shelves, bins and lockers. These become dried out or soaked with grease, oil or paint and make the worst kind of fire builders.

Messrs. Edward Darby & Sons Company, Inc., of Philadelphia, are now manufacturing and installing the "Pen-Dar" system of interior equipment, consisting of metal lockers, shelving, partitions, tables, and the like, which, it is claimed, are absolutely fire-proof, sanitary, and add materially to the cleanliness, neatness and appearance of any plant in which they are placed.

The "Pen-Dar" metal locker, illustrated herewith, combines all the ad-

vantages of modern locker construction. It is made either entirely of sheet steel or of "Pen-Dar" expanded metal, the former being a dust-proof closet for use in wood-working factories, spice mills, colour plants, or any place where the protection of clothes from dust or powder is desirable.

The "Pen-Dar" expanded metal locker, as its name implies, is made of expanded metal by a new, patented process. This metal is made from a sheet of planished steel plate, cut, expanded, and then rolled in such a manner that it presents a smooth surface, entirely free from rough edges or corners. This style of locker is entirely of open mesh, it allows a free circulation of air, and, in consequence, is thoroughly ventilated.

They are made in groups and sizes according to requirements or specifications. Each locker is equipped with one shelf, three nickel-plated coat hooks, an individual brass number plate, and a special three-point locking device, which securely fastens the door at the top, middle, and bottom with a single turn of the locking lever.

All locks are provided with two non-changeable keys, and each set has a master key. They are finished in Tuscan red, olive, green, or black enamel.

Locomotive Cranes for Coal Handling

THE new power house for the United States Naval Gun Factory at Washington, D. C., was recently completed. An interesting feature connected with this plant is the apparatus for receiving and storing coal and disposing of the ashes.

The apparatus was supplied by the Browning Engineering Company, of Cleveland, Ohio, and is shown in the two accompanying illustrations. It consists in part of a locomotive crane with auto-grab bucket placed on an elevated railway. This railway or trestle runs between a dock on the river front and the boiler house. Two hoppers, one at each end, are connected with the trestle. On top of the trestle runs the crane.

When the coal arrives in barges it is unloaded into the hopper car by the crane and the grab bucket, and as soon as the car is filled it is pushed by the locomotive crane to the upper end of the power house. The load is there charged through the bottom into the bin, and goes from the bin through the crusher, and is from there elevated and conveyed by a link-belt arrangement to the various storage points.

LOCOMOTIVE CRANE ON A STEEL TRESTLE SUPPLYING COAL TO THE WASHINGTON, D. C., NAVY YARD POWER HOUSE. BUILT BY THE BROWNING ENGINEERING COMPANY, CLEVELAND, OHIO

The main storage pile is located beside the trestle and next to the hopper, and after the stoker bins are filled, the coal is dumped from the car into this storage pile, and from there later on reloaded by means of the locomotive crane and grab bucket into the hopper, from which it goes to the crusher. It is the same way when the coal arrives by rail, the only difference being that the locomotive crane, instead of taking the coal out from the barges, takes it out from the gondola cars by means of the grab bucket, placing it either in the bottom dumping car on the trestle or direct on the storage pile.

The method for disposing of the cinders and ashes is identical, but reversed. The ashes are gathered and

THE POWER HOUSE FOR THE UNITED STATES NAVAL GUN FACTORY AT WASHINGTON, D. C. EQUIPPED WITH APPARATUS SUPPLIED BY THE BROWNING ENGINEERING COMPANY FOR HANDLING COAL AND ASHES

elevated from the boiler room to the top of the building by link-belt conveyors and are then automatically dumped in either one of two spouts. One of these spouts runs direct into a receiving hopper built underneath the trestle, and from which the ashes are dumped into railway cars. When the ashes have to be shipped by boat, the second spout is used, which conveys the ashes by gravity direct into the bottom dumping car on the trestle, and when this car is filled it is pulled by the locomotive crane down to the end of the dock where the receiving hopper is located and into which the ashes are dumped. A chute leads direct from the bin into the barges.

AN INTERLOCKING INSULATOR CLAMP MANUFACTURED BY THE CLARK ELECTRIC & MANUFACTURING COMPANY, OF NEW YORK

Insulator Clamps for Transmission Lines

INSULATOR clamps manufactured by the Clark Electric & Manufacturing Company, of New York, for use on overhead transmission lines, are shown in the annexed illustrations. They were designed to replace the weak tie wire and to make a mechanical connection between conductor and insulator, distributing the strain over as much insulator area as possible and allowing the conductor play through the insulator to prevent the hinging action resulting from sway.

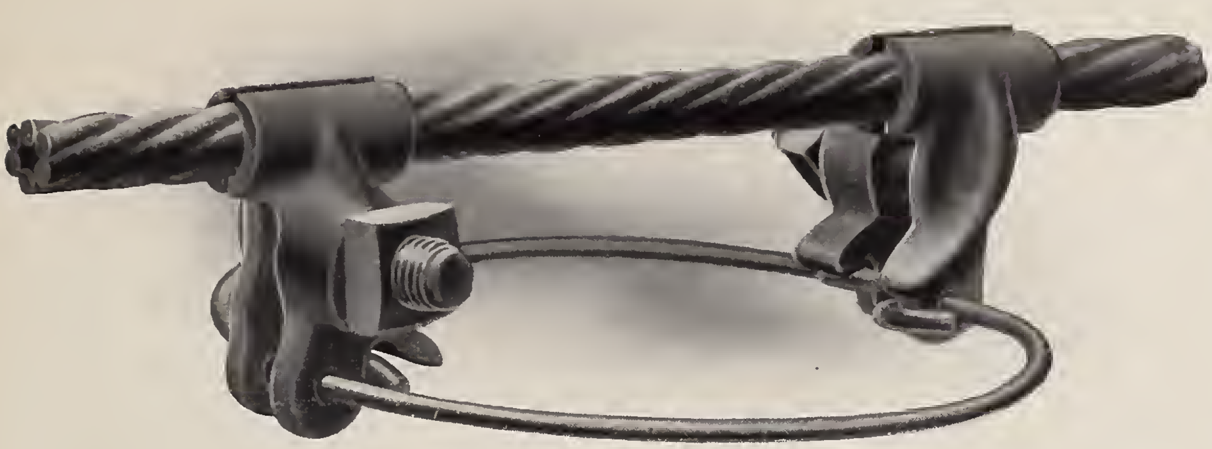
The interlocking clamp is used with a special insulator. The latter is constructed with an undercut recess on each side of the groove in the center of the insulator top, so that when the clamp is in position it is interlocked under the projecting portion in such a manner that the wire cannot be removed or the clamp separated from the insulator without unlocking the clamp.

The construction is such that the end strain on the clamp is distributed so that excessive pressure can at no time be concentrated on a small area of porcelain, and at the same time sufficient clearance is allowed so that the cable and clamp together may move freely when the cable or conductor is in place in the insulator, avoiding the hinge action which takes place when the wire is rigidly held in the insulator. This clamp is made in sizes ranging from No. 2 bare to 500,000 circular mils weatherproof.

The standard insulator clamp is designed for use with standard insulators. The two clamps are tightened firmly to the conductor on each side of the insulator by means of a bolt and a nut. The projecting lips engaging the groove of the insulator transfer the end strain to the porcelain in an effective manner. The loops surrounding the neck of the insulator hold the clamps firmly in position and prevent the conductor from being lifted from the groove.

The company also manufacture a copper splicing sleeve, illustrated herewith. These sleeves are made of pure seamless copper tubes, oval in shape, slightly spread at each end, and in sizes to fit any conductor used. The splice is made by running the ends of the conductor into the oval tube and then simply twisting from both ends.

Each sleeve is annealed by a process which secures a hard exterior wall with a soft interior, so that in twisting up the sleeve the hard exterior surface causes the sleeve to



AN INSULATOR CLAMP MANUFACTURED BY THE CLARK ELECTRIC & MANUFACTURING COMPANY FOR USE ON STANDARD INSULATORS

A COPPER SPLICING SLEEVE MANUFACTURED BY THE CLARK ELECTRIC & MANUFACTURING COMPANY

tighten over the wires and to partially embed them in the interior of the sleeve, which is considerably softer than the hard-drawn wires, thus giving a much greater area of contact between the wires and sleeves. The joint, moreover, it is claimed, permanently retains its conductivity, as the wires are pressed into the sleeve in such a manner as to prevent oxidation or deterioration in any form after the splice is made up.

Owing to the special process of annealing employed, it is claimed, the difficulty heretofore experienced by the sleeves splitting in making up the splices is overcome, and at the same time there is a satisfactory margin of safety over the tensile strength of the conductor. Special tools are furnished for twisting up these sleeves.

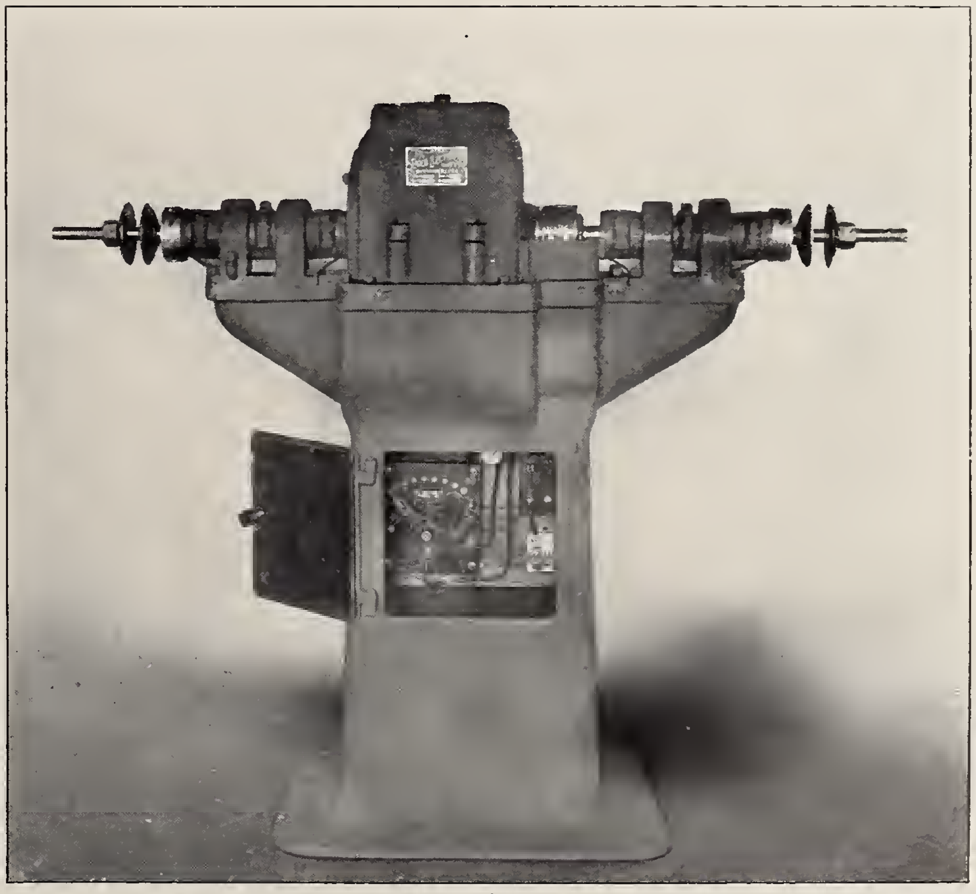
An Electric Buffing Machine

AN electric buffing machine built by the Eager Electric Company, of Watertown, N. Y., for operation on direct-current circuits, is shown on this page. The motor and arbour are supported upon a heavy cast-iron pedestal with projecting supports for the arbour bearings. The starter and switch are placed inside the pedestal. The motor has a capacity of 4 H. P., and is entirely enclosed. Dust caps over the ends of the boxes exclude dust and grit from the bearings.

The magnet yoke is of rectangular form, and is divided horizontally through the center; this permits removing the upper half so that the armature can be lifted out of the machine without moving the entire machine from its foundation or disturbing the bearings, which is necessary when several machines stand close together in a line if the machine is built with a solid magnet yoke.

The bearings are made long, to insure smooth running and long life for the machine. "Lumen" metal is used for the bearing bushings, and oil rings furnish oil to each of the bearings. The rings are enclosed by large recesses that are connected at the bottom to permit the oil to find its level between them.

Adjustment is provided so that the lateral motion can be taken up to prevent any jumping endwise of the arbour. The company claims that the entire machine is made in their shops, and that the motor is designed and built especially for buffing machine work. The machine operates at a speed between 2800 and 3000 revolutions per minute, and weighs complete, 970 pounds.



A MOTOR-DRIVEN BUFFING MACHINE BUILT BY THE EAGER ELECTRIC COMPANY, WATERTOWN, N. Y.

An English Storage Battery Locomotive

THE storage battery locomotive shown on the next page is one of two built by Messrs. Hurst, Nelson & Company, Ltd., of Mother-

STORAGE BATTERY LOCOMOTIVE BUILT FOR THE UNDERGROUND ELECTRIC RAILWAYS COMPANY, LTD., OF LONDON, BY MESSRS. HURST, NELSON & COMPANY, LTD., MOTHERWELL

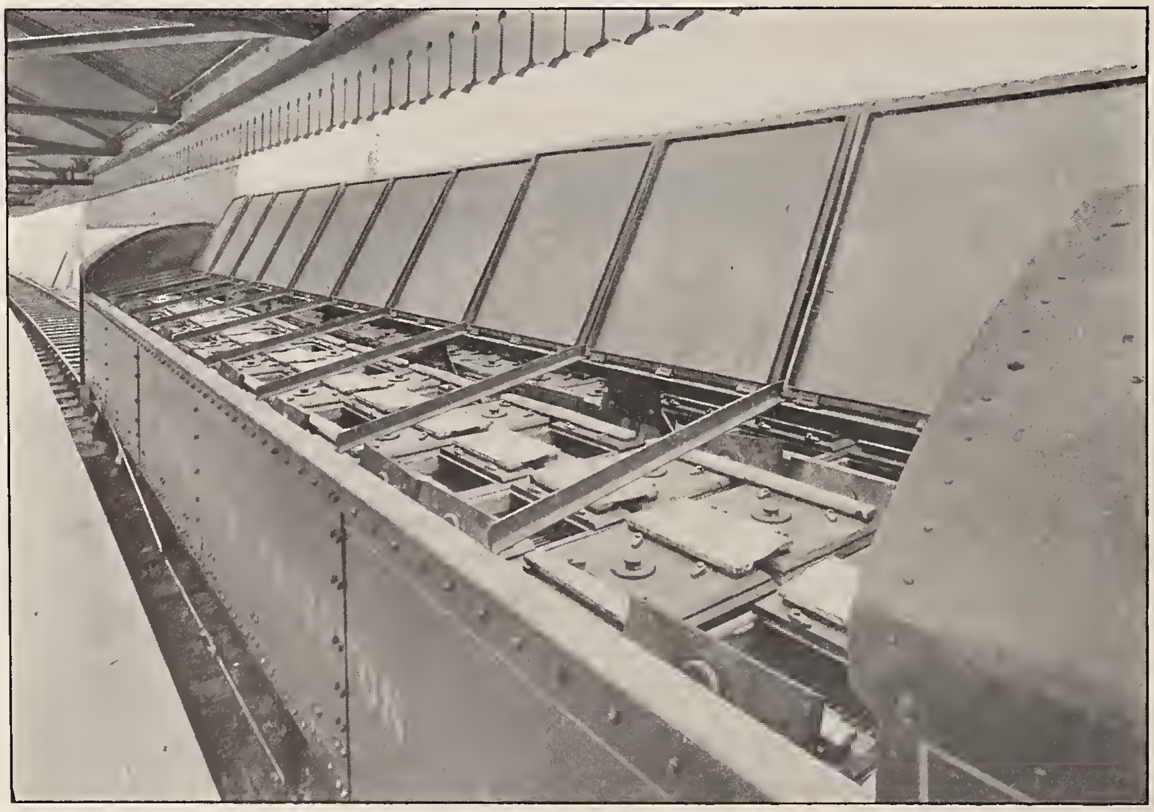
well, for the Underground Electric Railways Company, Ltd., of London, and is now in use for removing excavated material and carrying sleepers, rails, and other material required in the construction of the Great Northern, Piccadilly & Brompton Tube Railway.

The locomotive is 50 feet 6 inches long over buffers, and carries eighty chloride storage cells, supplied by the Chloride Electrical Storage Company, Ltd., of Clifton Junction, Manchester. The cells give a normal discharge of 179 amperes, and have a maximum emergency rate of 800 amperes, the total available energy being 230,400 watt-hours. They are contained in lead-lined wooden boxes with lids as shown in the interior view.

The motors are controlled by contactors and a master controller, the same as used on electrically controlled passenger trains, but instead of being supplied with current at 550 volts they receive current from the battery at 160 volts. Their working speed is about 8 miles per hour.

There is a master controller in each end cab, but the one cab is extended in length so as to hold the controlling apparatus, air compressor, and air receiver. The cabs are made entirely of steel, and are so arranged that they join the portion carrying the battery. This portion of the locomotive is divided lengthwise into two parts by a lattice girder frame, the top of which supports a series of sloping doors covering the cells. The locomotive is fitted with automatic centre coupler buffers and Westinghouse air brakes. The electric equipment was supplied by the British Thomson-Houston Company, Ltd., of Rugby.

The entire weight of the locomotive is about 65 tons, the battery alone weighing 31 tons. The wheels are 36 inches in diameter, and only two motors are used.



INTERIOR VIEW OF THE STORAGE BATTERY LOCOMOTIVE, SHOWING THE CELLS ON ONE SIDE

An Electric Water Hoist

THE problem of unwatering a mine is always a serious one to the mine management, especially so when the water is highly impregnated with acids. In the anthracite regions there are mines in which for every ton of coal raised, as much as fourteen tons of water must be pumped, and the latter must be done at a minimum of expense. Nowhere than there, probably, has a greater variety of pumps and lifting devices been tried, and the most sat-

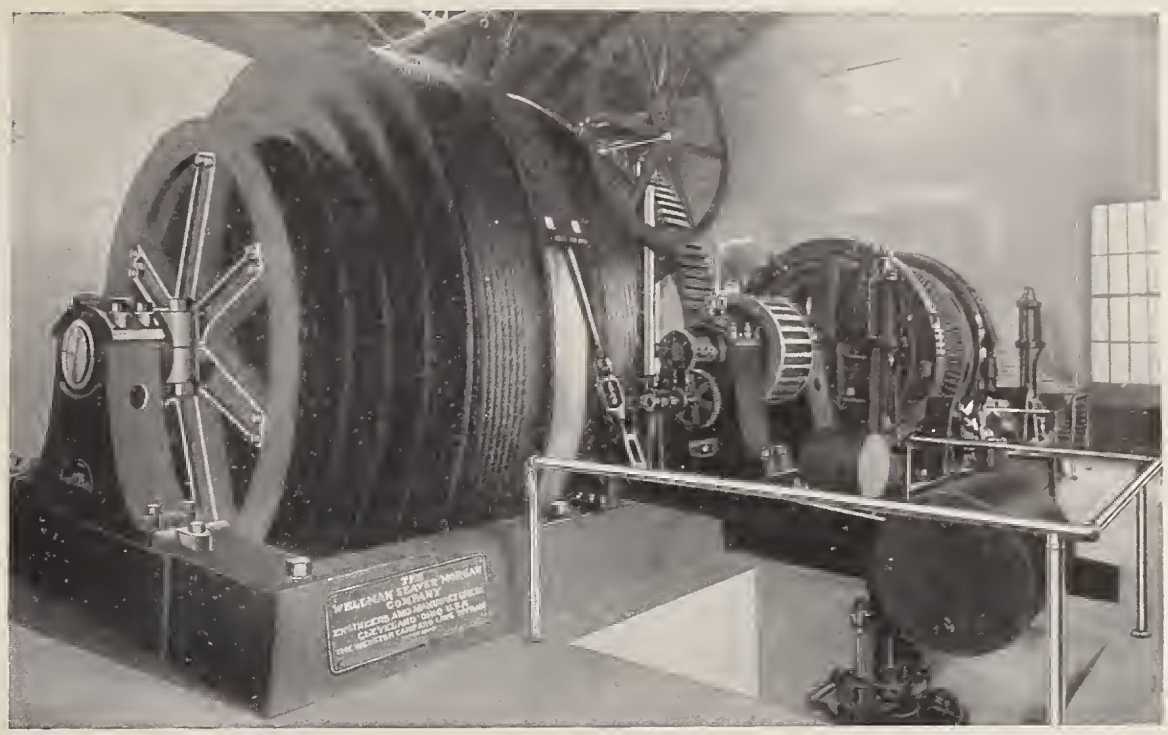


FIG. 1.—A MOTOR-DRIVEN HOIST BUILT BY THE WELLMAN-SEAVER-MORGAN COMPANY, OF CLEVELAND, OHIO, TO HOIST WATER FROM A COAL MINE

isfactory type for handling large quantities of water at comparatively low heads has there proved to be large bailers operated by steam engines.

These hoists, however, lack the mechanical regularity inherent in a pump, as they are necessarily operated by men. The Delaware, Lackawanna & Western Railroad Company, and their electrical engineer, H. M. Warren, finally developed a water-hoisting equipment which is claimed to preserve all the valuable points of the steam hoist, and at the same time operate automatically. The carrying out of the mechanical details of the hoist and its automatic devices was confined to the Wellman-Seaver-Morgan Company, of Cleveland, Ohio. Most of the electrical controlling devices were furnished by the Electric Controller & Supply Company, of Cleveland, Ohio.

In the original specifications, the Delaware, Lackawanna & Western Railroad Company called for the hoist to be operated by an alternating-current motor of 800 H. P., and the problem of starting, stopping, and reversing so large a motor had, at the outset, to be solved. The duty to be performed by the hoist called for the raising of 4000 gallons of water per minute to a height of 550 feet, and this required 610 net H. P. The weight on the rope was 53,235 pounds, or nearly twenty-seven tons, so that a 2-inch steel rope was used.

It was decided that it would be necessary to use with the hoist a motor running continuously in one direction on account of the heavy current otherwise required to operate the motor. The Delaware, Lackawanna & Western Railroad Company desired to use an alternating-current motor directly at the hoist, and as the motor was to run continuously in one direction, this necessitated the use of friction clutches for accelerating and reversing the load. As the Wellman-Seaver-Morgan Company had several smaller plants already in operation using alternating-current motors on hoists operated similarly to the present one, and as they were running successfully, and the repairs and renewals for clutches had not exceeded those required for the other hoisting engines, it was decided to use their method.

Figs. 1 and 2 show a front and side view of the hoist. As will be noticed the general arrangement consists of a motor driving a pair of bevel wheels through a single bevel pinion. The bevel wheels run loosely on a shaft and are fitted with friction clutches made by Webster, Camp & Lane, of Akron, Ohio. The operating mechanism for the clutches is so designed that only one clutch can be thrown in at a time, but both clutches can be out at the same time. Throwing in one clutch runs the drum in one direction; throwing in the other clutch reverses the motion of the drum.

To the shaft on which the bevel wheels run, there is keyed a pinion meshing with a main gear on the drum shaft. The drums are of the cylindro-conical type, 10 feet at the small diameter and 16 feet at the large diameter. At a hoisting speed of 550 feet per minute, the drum makes about fifteen revolutions per minute. There is one main brake, located between the drums. All of the clutches and brakes are operated by auxiliary air cylinders fitted with oil cushion cylinders, the compressed air being furnished by a motor-driven air compressor with the necessary tanks located near the hoist.

The hoist is controlled by the mechanical device shown in Fig. 2. This device consists mainly of a drum rotated by means of a friction drive from the motor, through a sprocket chain. The drum shaft transmits its motion to a secondary variable-speed shaft, which in turn operates a secondary stop. The main hoisting drum shaft operates a traveling nut, which is so located with respect to the controller drum that at either end of its travel it releases a stop and allows the controller drum to make a quarter turn; this movement, through suitable electrical connections, operates the solenoids on the clutch valve, releasing the clutch, and the solenoid on the brake valve setting the brake, the further movement of the controlling drum be-

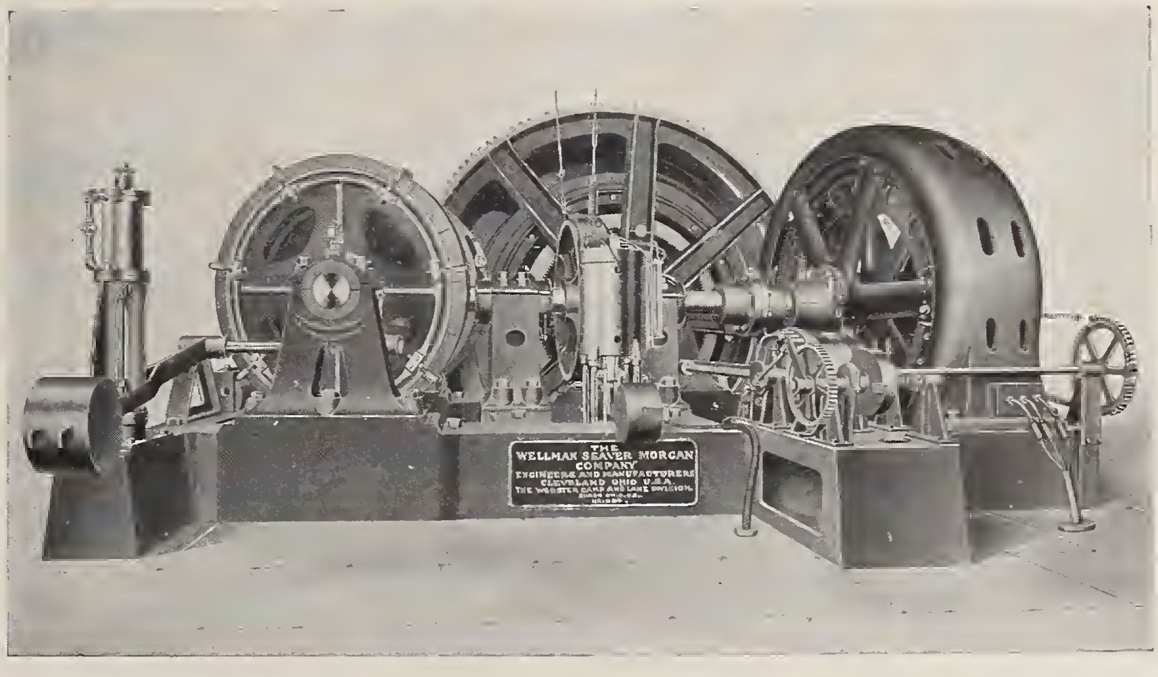


FIG. 2.—ANOTHER VIEW OF THE ELECTRICALLY OPERATED WATER HOIST

FIG. 3.—THE HEAD FRAME OF THE WATER-HOISTING EQUIPMENT, SHOWING THE BUCKET DISCHARGING

ing arrested by the secondary stop. The secondary stop is released by the variable-speed shaft and its connections, which have been given a predetermined time movement corresponding to the interval for emptying the bucket. The further movement of the controlling drum releases the brake and throws in the reversing clutch, thus starting the hoist in the opposite direction and also starting the traveling nut on the controlling mechanism in the opposite direction. At the end of the hoist the cycle of controlling movement is repeated, and so on, making the hoisting operation continuous and automatic.

Every attention has been given to the safe operation of the hoist. The main brake is of the gravity type, and to be released, the current must be on the solenoid operating the valve so that air can be admitted to the underside of the brake piston. If for any reason, either the supply of current or of air pressure is interrupted, the valve drops, and the weights on the brake lever set the brake. The clutches are designed so that they are thrown out by weights. As is the case with the brake, either clutch can only be thrown in when the current is on the solenoid and the air pressure admitted under the piston; if either current or pressure fail, the clutch is off. The motor shaft is fitted with an emergency brake operated by a weight controlled by a solenoid; any interruption in the flow of current to the motor sets the brake and stops the motor. Any interruption of the current stops the machine, throws out the clutches and sets the brake. A safety cut-out is provided for in the head frame so that in case a bucket is carried beyond the proper height, the current is cut off.

Fig. 3 shows the head frame. This frame is 93 feet from the base to the center of the sheave at the top. It is built of structural steel, roughly, in the shape of an "A." From the head frame are suspended two buckets 6 feet in diameter and 19 feet 6 inches deep. The capacity of each bucket is seventeen tons of water. In the bottom of the bucket are located two lift gates with an area practically equal to the cross-section of the bucket. These gates are lifted automatically when the bucket reaches the top, and the water is discharged through the bottom into a spout fitted below the bucket, which deflects it to either side of the shaft. Each bucket makes a complete round-trip in 1 minute and 50 seconds, the total lift being 555 feet.

A new station for wireless telegraphy, according to the "Neue Freie Presse," is being installed at Norddeich, in Germany, on the North Sea. The area covered by its operations will have a radius of over 900 miles, and will include Germany, Austria, Switzerland, France, Great Britain and Denmark, as well as the greater part of Italy, Sweden, and Norway, and portions of Spain, the Balkan Peninsula, and Russia.

Personal

H. H. Westinghouse has been elected one of the trustees of Cornell University.

U. N. Bethell, vice-president and general manager of the New York Telephone Company, has returned from a brief trip to Europe, made for the purpose of securing much needed rest.

Dr. F. A. C. Perrine, consulting electrical engineer, of New York City, announces a change of address. His office is now in the suite of Henry L. Doherty, at 60 Wall street.

Robert McF. Doble, consulting engineer, of San Francisco, has severed his connection with the Abner Doble Company in order to resume his individual practice.

H. H. Suplee has been appointed to represent the American Society of Mechanical Engineers at the forthcoming commemoration of the two hundredth anniversary of the birth of Benjamin Franklin.

Cloyd Marshall has resigned his position as engineer in the power department of the Union Electric Light & Power Company, of St. Louis, and become connected with the American De Forest Wireless Telegraph Company at St. Louis.

Louis J. Magee, the representing director in America of the Allgemeine Elektricitäts Gesellschaft, of Berlin, has just returned to New York from a long trip to Europe, a large part of the time being spent on the Continent.

Max Loewenthal, who for several years past has been identified with the electric heating industry, has undertaken the development of an electric heating department for the Edison Electric Illuminating Company, of Brooklyn, N. Y.

A. P. Peck has joined the Allis-Chalmers Company and will hereafter be connected with the New York office of that company. He will travel throughout the New York district, giving attention particularly to the sale of power and electrical machinery. Mr. Peck is an associate member of the American Institute of Electrical Engineers. He was graduated from Purdue University in 1892 with the degrees of B. M. E. and E. E. Immediately upon being graduated he secured a place with the World's Columbian Exposition Company, and was identified with the electrical engineering department of the Chicago World's Fair until

January, 1904, as assistant engineer of arc lighting. From 1894 to 1896 he was with the Westinghouse Electric & Manufacturing Company. It was under his supervision during this time that the motors and wires were installed in the cars of the Chicago City Railway Company.

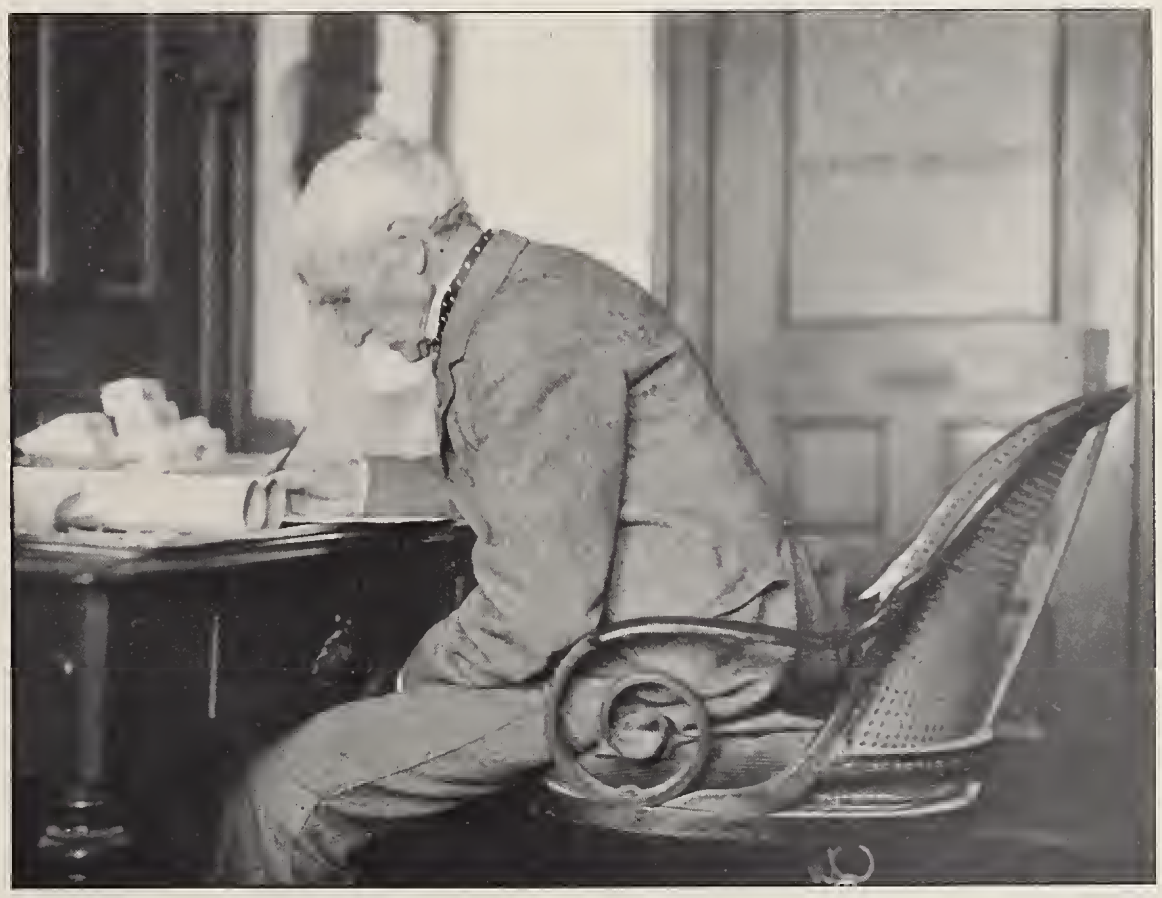
Henry L. Doherty, of New York city, has been elected a director of the New York & Queens Electric Light & Power Company. He is connected with many lighting companies, and had been general manager of the American Light & Traction Company properties.

Joseph Sachs, whose name has been intimately associated with the "enclosed fuse" development, is no longer connected with the Johns-Pratt Company, of Hartford, Conn., manufacturers of the enclosed fuse devices, which were invented and developed by him. The Arknot Company, of Hartford, Conn., has been organized with Mr. Sachs as president, and intends to do a general business in small electrical appliances and accessories, including devices such as those with which Mr. Sachs' name has been connected for several years. They expect to have a complete line of National Electric Code Standard enclosed fuse appliances ready for the market in the near future, and also a number of allied specialties.

Ralph D. Mershon, of New York, has been retained by the African Concessions Syndicate, Ltd., of London, in connection with the proposed development of power at Victoria Falls on the Zambesi River, Rhodesia, South Africa, and its transmission to Johannesburg and the Witwatersrand. The length of transmission will be about 700 miles and the power will be used in gold mining. Mr. Mershon recently made a trip to England for purposes of consultation.

To welcome Gisbert Kapp, the newly appointed professor of electrical engineering at the Birmingham University, from Germany, to which country he went in 1894, a dinner was recently given at the Imperial Restaurant in London. The welcome was an enthusiastic one, many congratulatory speeches being made. Among the prominent men present were Prof. W. E. Ayrton, Colonel R. E. B. Crompton, R. S. Erskine, A. H. Preece, J. Swinburne, Prof. W. C. Unwin and S. P. Thompson. Professor Thompson said that he was glad to think that the University of Birmingham did not advertise for the cheapest man to fill the professorship of electrical engineering, but communicated privately with Mr. Kapp, recognizing that he was the man to fill the post, just as they had done when Sir Oliver Lodge was appointed principal of the university.

Charles H. Haswell, the first incumbent of the office of engineer-in-chief of the United States Navy, now in his ninety-sixth year, was recently elected honorary member of the American Society of Mechanical Engineers. Mr. Haswell was born of English parents in the city of New York, descending from a family of staunch Royalists, who, after the defeat of Charles II. at Worcester, migrated to Barbadoes, W. I. After a classical education, at the age of about nineteen he entered the employ of James P. Allaire, of New York, the proprietor of what was then the largest steam engine building shop in the United States. There he laid the foundation for much of his practical engineering knowledge, and in 1836 entered the United States Navy as chief engineer, being commissioned engineer-in-chief in 1843. Mr. Haswell is the oldest living engineer in the world.



A RECENT PORTRAIT OF CHARLES H. HASWELL, THE OLDEST LIVING ENGINEER

A. E. Hoermann, mechanical engineer, who has been with the Curtis & Company Manufacturing Company, of St. Louis, for several years as chief engineer, has opened an office at No. 261 Broadway, New York City, as manufacturers' agent, and will make pneumatic machinery his specialty. He will represent the Curtis & Company Manufacturing Company as well as the Dayton Pneumatic Tool Company, of Dayton, Ohio, manufacturers of the Green hammer, and F. F. Slocomb & Company, of Wilmington, Del., manufacturers of the Caskey hydro-pneumatic punch and riveter.

President William H. Blood, of the National Electric Light Association, has reappointed the committee on "rates and costs" which made a report to the Denver convention last summer. The committee consists of Messrs. Charles L. Edgar, chairman; Louis A. Ferguson, Samuel Scovil, Frank W. Frueauff, P. G. Gossler and R. S. Hale. Mr. Geo. W. Brine, who was a member of the committee last year, declines on account of illness to serve again this year.

The Hendrick Manufacturing Company, of Carbondale, manufacturers of perforated metals and general sheet iron work, have placed Byram C. Guerin in charge of their New York office at 149 Broadway. Mr. Guerin was for the past two years connected with the firm of Clendenin Bros., of Baltimore, Md., importers of and jobbers in metals.

Thomas Commerford Martin has been appointed by President Blood as editor of "Progress," to report to the twenty-ninth convention of the National Electric Light Association, next May or June. Mr. Martin has for the past three years given to the association very comprehensive reports on the progress made during

each year in the various branches of the art in this country and abroad, and these reports have proved very valuable for reference purposes, as they contain data on so many subjects of vital interest to central stations. Aside from their usefulness they form a very complete and interesting record of the increasing use of electricity and its applications and appliances.

Lewis B. Stillwell, of New York City, has been appointed consulting electrical engineer of the New York, Westchester & Boston Railway Company, effective November 1, 1905. He will advise the chief engineer in all matters pertaining to the electrical and mechanical equipment, and will generally direct the work of the electrical department.

C. S. Powell, general agent of the Westinghouse Electric & Manufacturing Company, who has for some time occupied offices at 11 Pine street, New York, has removed to the offices of the company in the Trinity Building, 111 Broadway. The Westinghouse Electric & Manufacturing Company, in addition to their offices at 11 Pine street, occupy the entire nineteenth floor of the Trinity Building.

Obituary

Albert J. Pitkin, president of the American Locomotive Company, died at his home in New York City November 16, 1905, after an illness of several months. The serious character of his trouble was not appreciated even among Mr. Pitkin's closest friends, and the news of his death was a general surprise. At the head of the greatest industrial organization of its kind, Mr. Pitkin's leadership extended to circles even beyond national bounds. He was of that type found now more frequently than ever in the highest places in large consolidations—the man of operating experience who started in the humblest place in the shop or mill and traveled the whole length of the road to the position of greatest authority. From the days of his apprenticeship Mr. Pitkin was associated with the locomotive. He realized how much its development meant for human welfare, and set out to improve it to the utmost. The high position the Schenectady Locomotive Works attained among industrial establishments was due largely to his efforts. As the managing head of these works his influence upon industrial affairs reached quite beyond the locomotive. He originated many improvements in motive power methods and management. In arguing for the best development of the locomotive he often said, in substance, that the locomotive earns every dollar brought into the treasuries of the railroads; it therefore merits the best attention railroad men can give it. Mr. Pitkin was 51 years old.

Beauchamp H. Smith, second vice-president of the S. Morgan Smith Company, of York, Pa., died at his home in Los Angeles on November 1, at the age of 36 years. Mr. Smith went to Los Angeles about five years ago for the benefit of his health, since which time he has resided there, and hopes for a complete recovery were entertained.

Trade News

In response to the demands of their clients the Electrical Testing Laboratories, of New York City, have installed a machine for testing some of the mechanical properties of conductors. The rated capacity of this machine, in the measurement of tensile strength, is 15,000 pounds, which is sufficient to break a No. 0000 hard-drawn copper wire. By this addition to its equipment the company now has excellent facilities for all such tests of wires and cables as are ordinarily required in electrical practice. These comprise measurements of conductivity, insulation resistance, dielectric strength, electrostatic capacity, tensile strength, elongation, elastic limit, etc.

The Westinghouse Electric & Manufacturing Company will have a new line of ceiling and floor-column fan motors on the market the coming season, both direct and alternating current. These fans will have four blades and ball bearings, and be finished in black enamel and oxidized copper. The alternating-current fans will be of the induction type and direct-current fans will be furnished with three-point switches. The regular line of alternating and direct-current desk and wall bracket fans will be as complete as requirements demand, and the current consumption the lowest ever known for fans of these types. The company recently placed on the market also, a storage battery charging receptacle having many advantageous features, among the more important being a swivel attachment which conforms the receptacle to standard steam railway practice, and allows the car or vehicle to start and pull out the cables without danger of breaking them, or the contacts. The apparatus is adapted to both railway and automobile service, and has been adopted by the Pensylvania Railroad for charging the batteries on their cars.

Another of the Westinghouse Company's novelties is a line of three-phase core type transformers for 60-cycle circuits. One of these transformers may be used where three-phase transformation is to be made, instead of two or three of the single-phase type. They are self-contained units of compact construction, and reduce the complexity of wiring between the transformer and the apparatus which it is to supply. The company has just perfected a portable pipe-thawing transformer of 5-KW. capacity, also a choke coil to work in connection with standard 15 to 20-KW. lighting or power transformers, thus making standard capacity transformers available for thawing purposes in winter. The company has issued some interesting printed matter describing this apparatus.

The Public Lighting Commission of the city of Detroit, Mich., which, it will be remembered, established early in the nineties the first municipal lighting plant in America of high grade and considerable size, recently placed an order with the Westinghouse Machine Company, of East Pittsburg, Pa., for a 2000-KW. turbine type generating unit, following this order shortly afterwards with a second order for a machine of the same size. In the equipment of its power house on the river front in the center of the business district of Detroit, the commission has heretofore used vertical engines of the compound marine type. The early generator equipment was of the D. C. series type, the generators being rope driven from the vertical engines. Later the system was gradually replaced by the more modern A. C. series arch system with A. C. generators of the direct-connected type. The new turbine equipment thus represents another step in advance with respect to the compactness and modernization of the power equipment. The two new units will be installed in the original building, replacing some of the rope-driven machinery. Turbines will be of the standard Westinghouse-Parsons type, operating at a boiler pressure of 160 pounds without superheat, and at a normal vacuum of 28 inches. The generators will also be of standard Westinghouse design, of the revolving field type and with the enclosed generator frame construction.

The Jeffrey Manufacturing Company, of Columbus, Ohio, have established a New England branch, with offices in the Oliver Building,

at 141 Milk street, Boston, Mass. H. C. Freeman, for many years with the home office at Columbus, is the engineer in charge.

The Foos gas engine, made by the Foos Gas Engine Company, of Springfield, Ohio, received a gold medal as the "best single-cylinder horizontal gas engine" at the recent Exposition at Portland. The Foos engine has taken medals at all the expositions where it has been shown. The facilities of the Foos Company's plant are overtaxed to fill their orders, and a further addition to the plant is now under consideration.

Owing to the rapidly increasing Southern business of the past year the De La Vergne Machine Company, of New York, has established a branch agency at Atlanta, Ga., to cover the States of North Carolina, South Carolina, Alabama, Florida and Georgia. This agency will handle business connected with the three lines of machinery manufactured by the De La Vergne Machine Company, viz., refrigerating and ice-making machinery, Hornsby-Akroyd oil engines and Koerting gas engines. Their representative will be W. M. Hargreaves, and the office will be located at 510 Candler Building. The company recently received a contract for three 500-H. P. Koerting gas engines, to be direct-connected to 325-KW., 550-volt direct-current generators for the Boston Elevated Railway Company. These engines are to be put in operation about January 1, 1906.

The city of Alpena, Mich., which recently voted an issue of bonds to defray the cost of a municipal lighting plant, has contracted with the Allis-Chalmers Company, of Milwaukee, for the complete electrical and power equipment. This consists of a 60-cycle Bullock alternating-current generator, normal capacity 150 K. W., direct-connected to a Reynolds - Corliss cross - compound heavy-duty engine, an exciter unit, jet condenser, switchboards, sub-station apparatus, and equipment for 100 arc lamps connected in series. A feature of this installation will be its compactness, as provision has been made for the future enlargement of the plant, when the growth of the city demands it, by an extension of the existing building and the addition of another generating unit.

The Hercules vertical feeder support, manufactured by Colman J. Mullin, 430 Kent avenue, Brooklyn, N. Y., is a contrivance made to conform to Section 4, Rule 24, of the National Board of Fire Underwriters, issued last July. This device obviates the necessity of supporting the cables, as called for in the foregoing rule, namely, on porcelain insulators, but permits cables to run straightway through the box from one section of the pipe to the other. In conjunction with the Hercules support, Mr. Mullin makes also a sleeve which avoids the necessity of the pull box.

A steam railroad running from MacKey's Ferry to Beaufort, N. C., will be built for the Virginia & Carolina Coast Railway Company. This road will extend a total length of approximately 120 miles. The contract has been awarded to J. G. White & Co., 43 Exchange Place, New York, who will do all the clearing, grading, and track-laying work, as well as the building of steel bridges and viaducts.

Through the Gas & Electric Development Company, of Philadelphia and New York, a sale of the Washington Electric Light Company, of Washington, N. J., was recently effected. The purchasing syndicate is composed of New York, Easton and Philadelphia business men, who expect to make extensive improvements in the property. These are to be under the supervision of the Gas & Electric Development Company.

New Catalogues

The Jeffrey Manufacturing Company, of Columbus, Ohio, have issued a new catalogue illustrating machinery specially designed by them for handling coal at mines.

Francis H. Richards, of New York, has issued a pamphlet on foreign patents which gives useful information respecting the patent laws and requirements of the principal foreign patent-granting countries. His prices as given in this pamphlet include government and agency charges, as well as the preparation of all necessary documents, one sheet of drawings, and the translation of 1000 words in each of the different countries.

Cableways, tramways, suspension bridges, inclined planes, and cable railways built by the John A. Roebling's Sons Company, of Trenton, N. J., are illustrated and described in a very attractive catalogue recently issued by them.

Gasoline engines for small power are treated of in a bulletin recently issued by the Olds Gasoline Engine Works, of Lansing, Mich., who build these engines.

C. H. McGiehan & Co., of New York, announce on a card on which a thermometer is mounted, that they design and build automatic machinery for stamping and assembling articles in large quantities.

Leaflets illustrating and describing the motor-driven lathes and mills built by the Gisholt Machine Company, of Madison, Wis., have been issued.

The American Electrical Heater Company, of Detroit, Mich., present in an attractive way in a new catalogue the various electric heating appliances they make for use on ordinary lighting circuits.

The Pittsburg Transformer Company, of Pittsburg, Pa., have lately brought out a new publication to show the practicability of thawing frozen pipes by means of electricity, and also to call attention to their new electric thawing outfit.

A detailed description of the Westinghouse standard steam engine appears in an attractive catalogue recently brought out by the Westinghouse Machine Company, of East Pittsburg, Pa.

The C. W. Hunt Company, of West New Brighton, N. Y., illustrate and describe in a new catalogue the steam hoisting engines built by them for heavy duty in continuous service.

Rail-bonds as made by the American Steel & Wire Company, of New York, are treated of in a new circular.

Among the publications lately issued by the General Electric Company, of Schenectady, N. Y., are those on the Curtis steam turbine, the G. E.-80 railway motor, portable sub-stations for electric railways, direct-current multiple-enclosed arc lamps, Edison lamps, and incandescent lamp sockets for outdoor decoration.

Alternating-current generators are illustrated and described in a new bulletin issued by the National Electric Company, of Milwaukee, Wis.

The Electric Gas Lighting Company, of Boston, Mass., are sending out a mailing card calling attention to their exhibit of interior telephones and switchboards at the National Electrical Contractors' Convention at Mechanics' Hall, Boston.

Centrifugal pumps are dealt with in a catalogue recently sent out by the G. W. Price Pump Company, of San Francisco, Cal. The list includes cyanide, slime and sand pumps, dredging pumps, water-balanced vertical pumps, also pumps for water works, for hydraulicing and sluicing, in fact, for every class of service in which a centrifugal pump is desirable. The various types are shown arranged for belt, steam-engine, electric-motor or water-wheel drive. Illustrations are also given of a cement gravel mill, foot, check, and discharge valves, and flanges. Announcement is also made that the company makes a specialty of centrifugal suction dredges for harbor, river, canal, and like use.

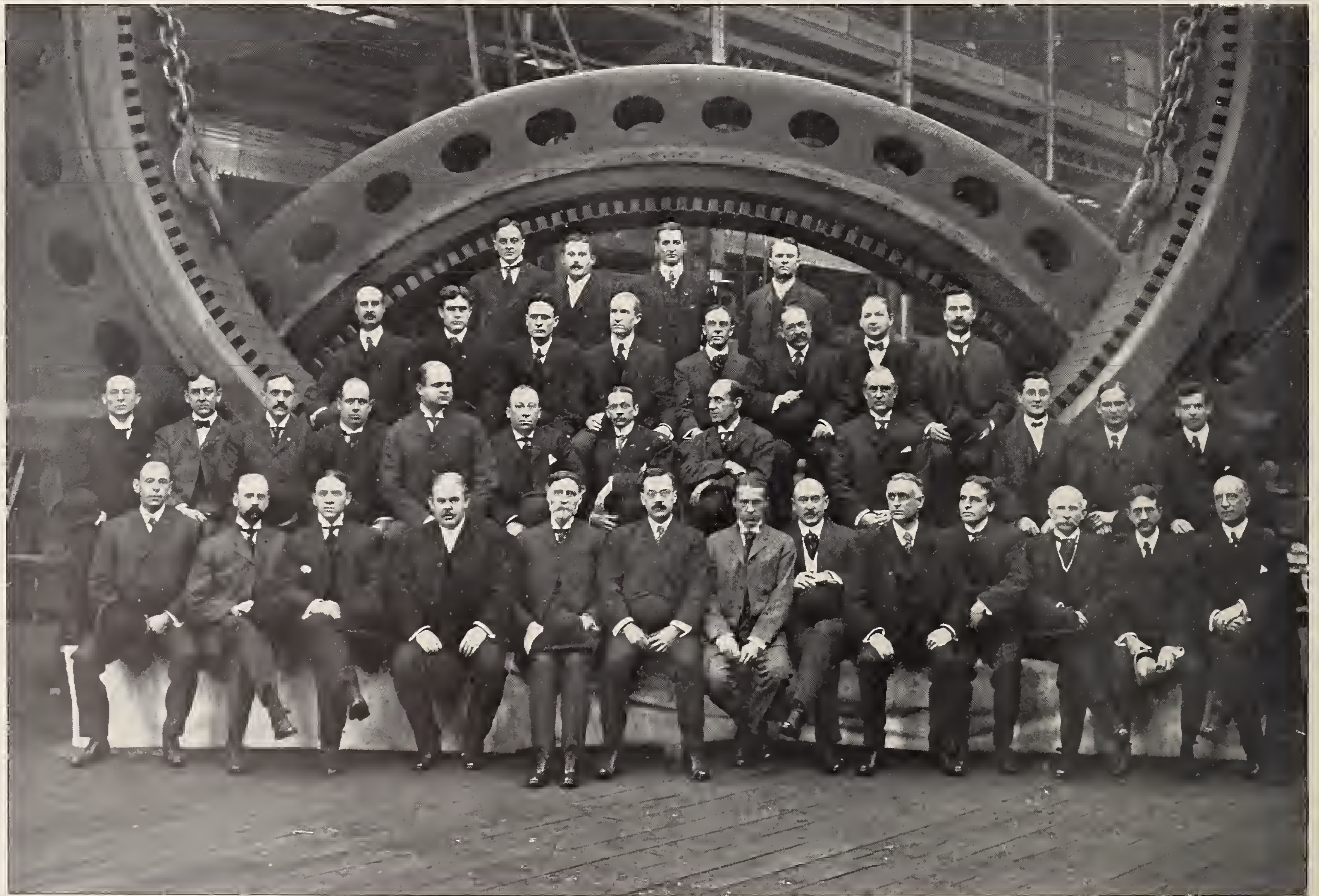
The Electrical Trades Exposition Company, representing the electrical interests of Chicago, have in preparation an electrical exhibition to be held at the Coliseum from January 15 to 27, 1906. Its purpose is to acquaint the trade and the general public with the many ways in which electricity can be applied, and with the numerous appliances on the market for this purpose.

Annual Convention of the District Managers of the Westinghouse Electric & Manufacturing Company

The annual convention of the district managers of the Westinghouse Electric & Manufacturing Company was held on November 13-16, at the general offices of the company at East Pittsburg. R. L. Warner, New England manager of the company, acted as chairman of the meetings, which were attended by the following representatives of the company:—C. S. Powell, general agent; W. F. Zimmerman, representative; Maurice Coster, manager export department; W. C. Webster, assistant to second vice-president; F. H. Shepard; all of New York city; G. Pantaleoni, general Southwestern manager, St. Louis, Mo.; J. R. Gordon, Atlanta; H. H. Seabrook, Baltimore; D. F. Manson, Boston; C. W. Underwood, Buffalo; T. P. Gaylord, Chicago; C. W. Regester, Cincinnati; G. B. Dusinberre, Cleveland; J. F. Johnson, Dallas; L. M. Cargo, Denver; C. F. Medbury, Detroit; T. J. McGill, Minneapolis; C. A. Bragg, Philadelphia; W. F. Fowler, Pittsburg; D. E. Webster, St. Louis; W. W. Briggs, San Francisco; M. P. Randolph, Seattle; Paul T. Brady, Syracuse.

At the opening session addresses were delivered by E. M. Herr, first vice-president of the company, by Frank H. Taylor, second vice-president, and by other officers. During the four days of the convention, papers on topics of general interest were read. On Wednesday evening the delegates and representatives of the local Westinghouse companies were entertained at the Hotel Schenley, by E. M. Herr.

At no time in the history of the company have the managers spoken with more enthusiasm of the business conditions in their respective territories. Maurice Coster, manager of the export department, said:—"I have it from the lips of a representative of one of the largest commercial interests in South America, that the people in those countries would rather buy American ma-



A GROUP OF OFFICERS AND DISTRICT MANAGERS OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, AT THE ANNUAL CONVENTION HELD NOVEMBER 13-16, AT EAST PITTSBURG. SEE KEY DIAGRAM ON PAGE OPPOSITE

chinery than European goods." Speaking further on the prospects for export business, he said:—"The outlook for foreign trade has never been brighter in this country than at present. The superiority of American machinery as compared with European manufacture is being demonstrated every day, and in those markets where the Germans and English have heretofore enjoyed a monopoly, America is now gradually obtaining the lion's share of the business. As far as the Westinghouse companies are concerned, we are enjoying the particular advantage that the name of Westinghouse is well known the world over, that our goods are used in every country on the globe, and hence we have no difficulty to obtain business for our companies."

Among the other attendants at the managers' meeting, R. L. Warner, the New England agent, said:—"The business outlook in New England was never brighter than at the present time, and especially does this refer to the Westinghouse Electric & Manufacturing Company. Our product is constantly growing in favour, and I also believe that the fact that the New York, New Haven & Hartford Railroad Company is about to operate its trains by the single-phase locomotive will be a great factor in the electric railway business of the Westinghouse companies."

F. H. Taylor, second vice-president, spoke as follows:—"I feel that this is a subject for congratulation, not only of ourselves, but also of the entire business interests of Pittsburg, and that the prospects for prosperity in our works never will be brighter than at present. While we are already in possession of the facts which prove that the year of 1905 has been the banner business year in the history of the factory, we have every reason to believe from the assurances given us by our district managers from all over the country, who have been in session here, that the industrial advancement throughout this country promises an unprecedented activity, and that our company will reap the benefit of this activity in a measure perfectly satisfactory. I look for the business of 1906 to be materially larger than that of 1905."

C. S. Powell, general agent, of New York city, said:—"The adoption of electricity by the Pennsylvania Railroad on its lines, Eastern division; by the New York Central on part of its lines, and the decision of the New York, New Haven & Hartford Railroad Company to operate trains with the single-phase locomotive, will prove a great impetus towards increasing the future business in the electrification of railroad lines throughout the country. As the progress and development of this matter began in the East, so I foresee the advancement of electric railroading in the fact that these Eastern railroads have set the ball rolling in that direction."

1. T. P. Gaylord.
2. D. E. Manson.
3. W. C. Webster.
4. W. M. McFarland.
5. Paul T. Brady.
6. E. M. Herr.
7. R. L. Warner.
8. W. C. Kerr.
9. Frank H. Taylor.
10. L. A. Osborne.
11. Maurice Coster.
12. James C. Bennett.
13. W. F. Zimmerman.
14. J. T. McGill.
15. M. P. Randolph.
16. B. G. Griffin.
17. J. R. Gordon.
18. H. C. Ebert.
19. S. L. Nicholson.
20. W. W. Briggs.
21. C. S. Powell.
22. Walter Cary.
23. C. W. Register.
24. F. H. Anderson.
25. Guido Pantaleoni.
26. L. M. Cargo.
27. John D. Mickle.
28. D. E. Webster.
29. C. W. Underwood.
30. W. F. Fowler.
31. C. A. Bragg.
32. F. F. Rohrer.
33. C. B. Humphrey.
34. J. E. Johnson.
35. H. H. Seabrook.
36. A. H. Masters.
37. H. W. Cope.

T. J. McGill, the Northwestern agent, located at Minneapolis, in speaking of the business outlook in that part of the country, said:—"Every indication at present in the Northwest leads me to believe that 1906 is going to be the greatest year in history. The record-breaking crops of 1905, at high market values, have greatly increased our local wealth and have attracted a large volume of outside money for investments. The railroad traffic, all building operations and bank clearances have had a marvelous increase and a healthy one. Further, the beneficial results are pre-eminent. At one time the Northwest was only known as a sparsely inhabited section, but we must now agree with J. J. Hill, who says that it ranks as an empire."

According to J. R. Gordon, the representative of the South, with headquarters at Atlanta, "the development of the South within the last five years has been truly phenomenal. Business, commercial and manufacturing enterprises are daily increasing. Electricity has had as much to do with this development as any other factor, on account of the fact that it has made possible utilization of the many waterfalls which are located in that section of the country. These waterfalls are now being rapidly developed and the power is used for driving the machinery in the old manufacturing plants and gives a new impetus to the establishment of others."

L. M. Cargo, representative for the district comprising Colorado, New Mexico, Wyoming, Utah and Idaho, remarked that "the new discoveries of valuable minerals are made in our district almost every hour, and the wealth of gold, silver and copper, especially the latter, is inestimable. This means a greater development of the mining industry of that country than has yet been dreamed of, and, inasmuch as the application of electricity makes the operation of mines an easy task, we are looking for a great business in that branch of the industry."

W. W. Briggs, of San Francisco, said:—"The people on the Pacific slope are looking forward to a period of uninterrupted prosperity. I believe that the development of interurban railway business has only just commenced, and with the perfection of the single-phase locomotive and the steam turbine, this particular branch of the business will be very much greater than it has been heretofore."

To C. A. Bragg, of Philadelphia, the prospects for next year appeared most flattering; he said:—"If we have had success in the past and banner years, I think the coming one will make them look insignificant as regards the amount of profitable business ahead of us. There is nothing in the horizon, that I can see, which will interfere with, not only our own business, but the general prosperity of the country. The indications are so strong that I cannot see how they can in any manner be harmed."

Electrical Conveniences for the Home, Office, and Shop

By WILLIAM H. RADCLIFFE

MUCH as electricity has done in adding to the comforts and conveniences of the home, office, and shop, it promises yet more, for scarcely a week passes during which there is not brought out some new appliance that may be attached to the ordinary lighting circuit or fixture for increasing the value of the service. The average consumer of electricity, however, after the novelty of employing electric light and fan motors has worn off, pays little attention to the many ways in which he could still further profit by the use of current, either in the new appliances referred to or in the new ways of utilizing the appliances he has already in service.

In the home, the flexibility of the lighting system as ordinarily installed can be greatly increased by means of three-way switches. These switches enable one to control the lights from different places; thus, the lamps can be lighted by one of these switches and turned out by another at a distant point, or vice versa. In a house, for example, where lamps are installed in the lower hallway, the turning of a three-way switch, mounted conveniently near the entrance, will light the hall and stairs, and if it be desired to turn out these lights after climbing the stairs, this may be done by means of another three-way switch at the top of the stairs.

There are many parts of a house where an incandescent lamp of 4 or 8 candle-power will serve practically as well as the ordinary 16 candle-power lamp, and at a much lower cost of operation. Incandescent lamps of low candle-power are made to fit the standard lamp sockets, and may advantageously be used for lighting closets, store-rooms, halls, and porches, and in lamp globes and Oriental lanterns for ornamental illumination. As an all-night hall light or as a porch light bearing the house number, these low candle-power incandescent lamps are of great convenience, and the few cents of cost per night in burning them is money well spent as insurance against robbery, for other things being equal, a burglar will always pass a lighted house for one not lighted.

There usually are many places in a house where provision has been made for but one lamp, and neither a high nor a low candle-power lamp properly answers the purpose. For such cases there are "turn-down lamps" controlled by resistances inclosed in the lamp sockets, and there are also lamps in which two filaments are employed, one filament giving 16 candle-power and the other a light of lower intensity. Special forms of lamp sockets, however, are required for both these types of lamps, and the position of the key determines the intensity of the light.

For convenience in turning on and off incandescent lamps mounted so high as not to be easily reached, pull sockets may be used. Chains of any desired length may be connected with these sockets. Pull sockets will be found useful also in connection with clusters of lamps where, by a straight pull of the chain, all the lights may be turned on or off at once, and by pulling the chain to one side, any one or more of the lights can be operated.

The ordinary pendant or long-distance switch is also a simple and convenient device in the bedroom or elsewhere for turning on or off lamps mounted out of reach. It is connected to the lamp fixture by means of an extension drop-cord, which may be of any length to suit the requirements. There are also wall switches that answer a similar purpose, but these are more troublesome to install after a house has been wired.

Portable drop-lamps for reading or working purposes are of great convenience. One of the most desirable types consists of a standard with a flexible metal support, by means of which the lamp is held so as to permit of freely adjusting its height above the table. The lamp is also held horizontally and covered with a half-shade so that the full 16 candle-power of light is available for use. Such a lamp may be connected to the ordinary lamp socket if an attachment plug be joined to the wires leading from the lamp and screwed into the socket.

A few words, here, concerning the lamps themselves:—An ordinary incandescent lamp gives, when new, 16 candle-power; after burning 400 or 500 hours it depreciates so as to give but 14 or 15 candle-power, and after doing service for 600 hours the light drops to about 13.5 candle-power, continuing to diminish in efficiency until at 800 or 1000 hours it may decrease to 6 candle-power. It is therefore advisable to date the lamps when installed, and to replace them with new ones after 600 hours' service, as beyond that age they not only give poor light but consume more than the ordinary amount of current.

Devices that may be attached to the ordinary lighting circuit or fixture in the home for utilizing the heating effect of the current are so numerous as to prevent their being described in detail here. There are, for example, electric curling-iron heaters that heat quickly, use no more current than an incandescent lamp, and are much safer and cleaner than those heated by other means; electric heating pads to supplant the cumbersome hot-water bottle, giving a uniform heat, easily attached to a lamp socket for immediate service, remaining hot as long as desired, and which, being covered with an outer casing of eiderdown or rubber cloth, which is removable and washable, are soft, light, flexible, and perfectly sanitary; electrically heated glue pots requiring no fire, and causing no smoke, dirt, or danger, that heat the glue quickly and also maintain it at its proper consistency; electric chafing dishes so much superior to the alcoholic types, being always ready, clean, safe, inexpensive to operate, and easily regulated to provide the desired amount of heat; electric flatirons that can be connected to a lamp socket by flexible wire cord, and which are quickly heated and remain evenly hot under the most constant use, so that no work need be delayed by a cold iron or scorched by an overheated one; nursery milk-warmers that will heat

milk from 60 to 110 degrees F. in 3 minutes; electric stoves, ovens, and warmers for boiling water, warming plates, making toast, tea, coffee, broiling and roasting meats, and for various other culinary operations.

Electric radiators well adapted for temporarily heating a room on chilly days may be connected to the lighting circuit without trouble, and will be found ornamental as well as useful, hygienic, and easily controlled. The principal objection to utilizing the heating effect of the current has been the slight additional cost of the apparatus and its operation over other means and methods, but this cost of late has been steadily diminishing until now it is, in many of the electric heating devices, small in comparison with the increased convenience attending its use.

Coming, now, to the application of the electric motor to domestic service, there is the electrically-driven sewing machine, the motor occupying an inconspicuous place under the table, yet relieving the mistress of a burdensome household duty. A slight change in the position of the treadle starts, stops, or changes the speed of the machine, so that better control is obtained and far less strength is required than with the use of the old pedal. The electric piano player is another device in which the electric motor supplants manual operation.

The electric fan motor as a summer convenience for ventilating living rooms, and particularly sickrooms, is so well known and generally applied as to need no particular mention. Its use as a convenience in winter, however, is not so well understood, but if properly employed it can be made to considerably increase the efficiency of a steam radiator or that of a furnace. If the fan motor be placed so that it forces air against a heated radiator, much more heat will be conducted away from the surface of the radiator than if it were heating in the usual way. With a radiator ordinarily too small, a fan motor will thus enable a room to be comfortably heated. In hot-air heating systems the air flues leading to distant rooms are often too long and have too many bends to circulate properly, but by using an electric fan to create a draft near a register the warm air in the flue is readily drawn up.

Many of the devices and methods previously mentioned as affording convenience in the home are also well adapted to office use. Low candle-power lamps, for example, will give sufficient light for the store-room, the telephone booth, the reception hall, and for other places where a general illumination rather than a high degree of brilliancy is required. In connection with this it is well to bring to notice the usual custom in offices of giving no attention to incandescent lamps from the time they are screwed in their sockets till they burn out; very rarely is any account kept of the number of hours they have been giving service, and no attention is given to their diminishing candle-power. They are seldom washed or even dusted, yet the accumulation of dirt and dust on the bulbs has a very material effect on their illuminating power.

Drop-lamps of one type or another are absolute necessities for office work; many office employees find the small electric stove connected to a lamp socket a great convenience for making coffee, warming luncheons, etc., especially on stormy days. Electrically-driven typewriting machines are now being used, and electric fan motors have been found of such value for increasing the efficiency of employees during the summer months, that few offices are without them. By employing fans to increase the efficiency of heating systems, as already explained, they will be found useful in winter as well as in summer.

The shopkeeper who uses electricity for general lighting, but does not avail himself of the advantages and conveniences afforded by the current for advertising purposes is not improving all of his opportunities. An illuminated sign costs more than an unlighted painted board, but the results obtained, especially during the winter months when darkness comes early, are usually large in comparison with the increased cost. Of illuminated signs, those lighted by electricity surpass any other kind in convenience and effectiveness. Economy in the use of large electric signs, together with increased effectiveness, can be obtained with the use of a "flasher," by means of which a portion of the sign is left in darkness for a few seconds, while the remainder is lighted, the sudden shifting of the illumination making the sign more conspicuous to every passer-by. The current required to operate the "flasher" is not more than that taken by an ordinary 16 candle-power lamp, and by a system of adjustable lugs, almost any desired lighting effect can be obtained.

Movement suggests life, and a suggestion of life from where it is not expected, arouses curiosity. It is for this reason that "flashers" and other animated electrical displays are of great value to merchants in attracting the attention of the public. One of the more elaborate advertising window devices of this nature consists of a cabinet about 4 feet high, the upper half being provided with a glass front. Inside the glass are mounted a series of mirror glass slats, pivoted centrally at each end, and turned to four positions automatically every 20 seconds, by means of a rod connecting with the side frame and operated by an electric motor in the base of the cabinet. When the narrow mirrors are closed, the entire glass front has the appearance of a large mirror. When the mirrors are slanting downward, a coloured transparent hand-painted silk advertisement inside may be seen apparently moving into position on the mirrors. The mirrors next assume a horizontal position, enabling the advertisement to be seen directly, and the next movement shows it on the mirrors again, after which the mirrors close to the first position. At every shift the image is apparently moved to a new position, and as twenty different advertisements may thus be shown within 7 minutes, the display is of more than passing interest. A small electric motor is used for producing the motion, and electric lamps are employed for the transparencies.

A window attraction of a less pretentious nature, but none the less interesting may be arranged by placing an electric fan motor within a small barrel or keg, with the blades of the fan facing upward. If a wire netting be stretched across the open end of the barrel several inches below the top, and narrow firey-coloured ribbons be fastened to the netting, the breeze from the fan will cause the ribbons to wave in profusion from the top of the barrel and present the appearance of flames arising from within. Another simple scheme consists in enclosing a show window and placing a dozen or more coloured toy balloons in the enclosure together with an electric fan motor. The balloons in response to the currents of air from the fan will float about in a way that will attract much attention to the window. It is thus seen that electricity lends itself as readily to the merchant for advertising by day as it does for advertising by night.

It is to be assumed that shop keepers who use electricity for general illumination appreciate the advantages from an advertising point of view, of an effective system of show-window lighting for display purposes. Not only have the merits of the electric incandescent lamp made it the best adapted illuminant for this purpose, but by the use of a new device known as a time switch, the convenience of the electric sys-

tem can be still further enhanced. With the time switch in circuit, the lights in the shop are automatically turned on at any predetermined time, and also turned off at night in a similar manner. To illustrate the great convenience thus afforded, suppose a merchant desires to close his place of business before it is dark, or before the evening crowds are upon the street; all that is necessary in order to have his show windows and signs lighted at the proper time, and later on in the evening cut off, is simply to set the clocks on the time switch accordingly. In a similar manner his windows and signs may be temporarily lighted up for a theatre crowd during a thirty or fifty-minute period.

The dentist, the baker, the cigar-shopkeeper, all find in electricity, conveniences of inestimable value. The dental drill and the tiny surgical bone saw are both dependent upon the electric motor; the electrically-driven mixer costs for operation less than one-tenth the wages of a man to mix the same quantity of dough by hand, and the work is done more thoroughly and uniformly; the electric cigar lighter can be used on any 110-volt circuit, and is a safe and attractive substitute for other forms of cigar lighters. In the studio the photographer will find the Cooper Hewitt mercury vapour lamps connected to the commercial direct-current lighting circuit a convenient substitute for daylight in making exposures, and in shops and similar places where a particularly steady light of high efficiency and of a character approximately equal to that of daylight is needed, the Nernst lamp connected to the commercial alternating-current lighting circuit is recommended. Restaurant keepers who have much dish-washing to be done find electric dish washers of great convenience, and a few ribbon streamers attached to the guard frame of a fan motor in operation constitute withal a very efficient means of keeping flies, insects, and dust away from fruit, pastry, and other eatables.

Several useful applications of the fan motor during the winter months have already been mentioned. There is yet another one that will appeal to the merchant whose show windows in cold weather are usually covered with frost, obscuring his display. It consists in placing a fan motor in the window so that it will blow gently toward the glass panes the warm air from the main portion of the store. The glass soon becomes warmed and all the frost melted, the moisture bebeing carried off by the dry air.

New Telephone Bond Issue

THE stockholders of the American Telegraph & Telephone Company are to meet on December 21 to authorize the issue from time to time of $150,000,000 of convertible bonds. This is the company which controls through the ownership of part of their stock all the local telephone companies in the country operating under the Bell patents, except those in Michigan, and the long-distance lines connecting them. At the present time it has $131,551,400 of capital stock outstanding, and about $88,000,000 of bonds.

According to the circular which has been sent to the stockholders the bonds will be issued from time to time as business may require, with the right to convert them into stock after two and not more than twelve years at a price not less than par. No specific explanation for this enormous bond issue is given in the circular beyond the statement that the policy of extending and developing business will require the additional capital. The Southern Bell Telephone Company, which is controlled by the American company, recently sent out a circular to its stockholders calling for an increase in the capital stock from $1,000,000 to $30,000,000.

The American's circular says that the company has sufficient cash in its treasury to meet all needs until well in to 1906, but that the directors believe it advisable to have authority to issue bonds in order to act quickly in case favourable opportunities arise. This explanation of the finances of the company is given:—

"Heretofore the capital required by your company has been provided either by the issue of stock or by the issue of its 4 per cent. collateral trust bonds, payable in 1929, except that in the spring of 1904 there were issued debenture notes of the company to the amount of $20,000,000, payable May 1, 1907, and secured by 4 per cent. bonds of the issue above described to the amount of $25,000,000.

"At the present time the amount of issued capital stock upon which dividends are paid is $131,551,400, and the amount of the 4 per cent. collateral bonds (including bonds of the American Bell Telephone Company to the amount of $10,000,000, due in 1908, which may be treated as part of the issued collateral bonds) is $88,000,000, of which the bonds to the amount of $25,000,000 which underlie the $20,000,000 of 5 per cent. debenture notes, will be returned to the treasury of the company when the debenture notes are paid.

"In view of the necessity of securing further capital for the constantly increasing business of the company on as favourable terms as possible, it is clear that the company should not be limited in its financing to the forms of security which it has heretofore issued.

Electric Traction in the Simplon Tunnel

THE opening of the Simplon Railway, according to "The Electrical Review," of London, is expected to take place about the middle of 1906, with steam locomotion by way of a beginning, although the Italian Government has already declined any responsibility for steam traction in the tunnel. It had been proposed by Italy that electrical working should be introduced according to the system used on the Valtellina Railway, and as Switzerland is to work the Simplon Railway, the government was asked to make an inspection of the Italian line in question.

As a result of the investigation of the railway, which is now equipped with new locomotives capable of hauling at the desired speed the heaviest trains to be used on the Simplon Railway, it is reported that Switzerland will begin the work for the adoption of electric traction. The question is to be pushed forward as much as possible, and further negotiations on the subject are to take place at Rome.

In the meantime, the Swiss Federal Council has to settle the problem of the water-power required for the generation of electrical energy, and the report has yet to be received of the two engineers who are still investigating electric railway questions in the United States.

A convention of the International Tramway & Light Railway Union will be held at Milan in September, 1906. Among the principal questions to be solved by the convention will be one relating to the best means of braking employed by electric tramway systems; the most convenient dimensions, especially length and width of the cars; the maximum permissible speed of tramways on roads and on private rights of way. There will also be consideration of the length of rails and rail-jointing, etc. Steam turbines and their applications to electric traction are to be discussed, as are gas engines also. Other minor questions include the use of meters on cars.